SPECIAL COLLECTOR'S EDITION

SCIENTIFIC AMERICAN

The Science of Living Your Best Life

Boost creativity with naps

Challenges make life rich

Conquer burnout

How exercise slows aging

What meditation does to your brain

FALL 2023

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Road to Fulfillment

IN 2021 MORE THAN 40 PERCENT of workers worldwide considered quitting their jobs in what Anthony Klotz, a professor at University College London's School of Management, coined the "Great Resignation." The COVID pandemic had unraveled the normal fabric of life. From work commutes to school lessons and family gatherings, the world was different by most metrics. In the months and years that followed, it seemed like many people reassessed what they wanted their life to be, and work was just one part of it. This collection of articles is for all those trying to become more authentic, creative and healthy versions of themselves.

Start by looking inward. The 10 practices of self-actualized people include accepting one's quirks and finding a purpose (*page 4*). Even the most challenging circumstances imbue experience with a kind of richness—a psychologically complex life ranks among the more rewarding types (*page 12*). No matter our past experiences and future desires, exciting research points to one key region of the brain that maintains the sense of self (*page 8*).

Even challenging circumstances imbue experience with richness—a psychologically complex life is rewarding.

Nurturing a creative spirit is key to authenticity. Sparks of insight aren't spontaneous but instead can be cultivated in five key stages (*page 20*). Partaking in regular play (yes, adults, too) helps us try out new ideas (*page 30*), and even quick naps can zap fresh thoughts into the brain (*page 26*).

Whether in play or work, we have an evolutionary aptitude for getting along with others (*page 38*), and random acts of kindness may have a larger ripple effect than expected (*page 44*). Adults who are kind and helpful probably learned in childhood to respect the feelings of others—a skill that can be developed anytime (*page 84*). Even with jobs that fulfill and inspire us, burnout can mount without proven tactics to fend it off, which include fostering resilience (*page 98*) and engagement (*page 52*).

Stay sharp with physical activity that challenges the heart and the mind (*page 58*). In turn, brain health spurs body health, according to recent research that suggests a positive outlook bolsters the immune system (*page 72*).

Some science-derived tactics for surviving the stress of the modern world: stop scrolling and put down the phone (*page 108*); build a meditation practice—preliminary studies show it can enhance focus and mood (*page 90*); and fine-tune parenting skills with advice derived from neuroscience on how to communicate with teenagers (*page 78*).

The synthesis of these evidence-backed approaches to life might just constitute a road map for an enriching existence. But the choice of which pursuits, occupations, ideas and paths to embrace comes down to one element: you.

Andrea Gawrylewski
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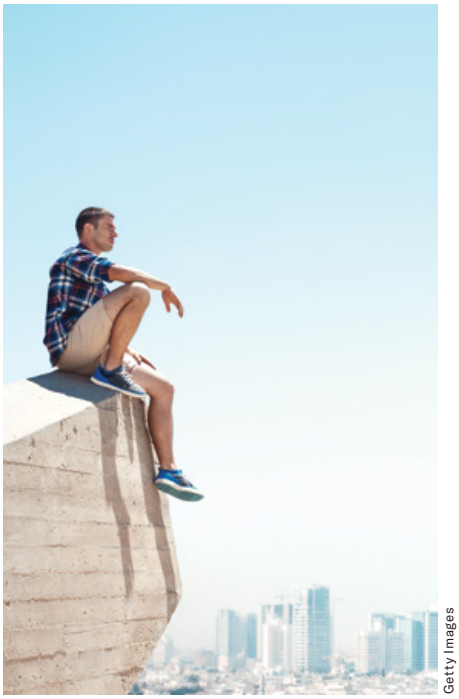
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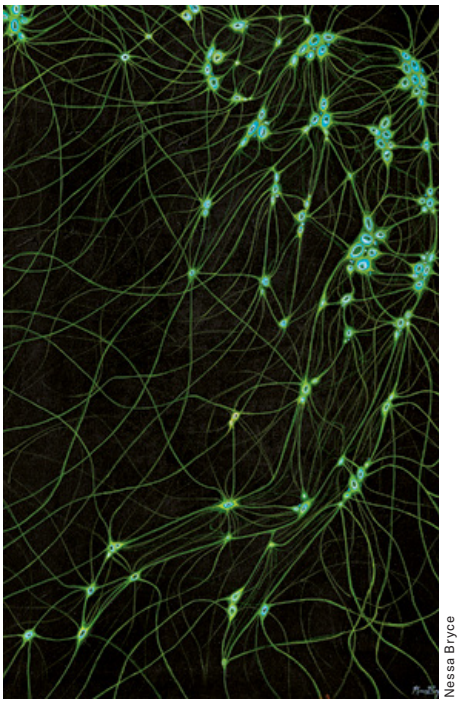
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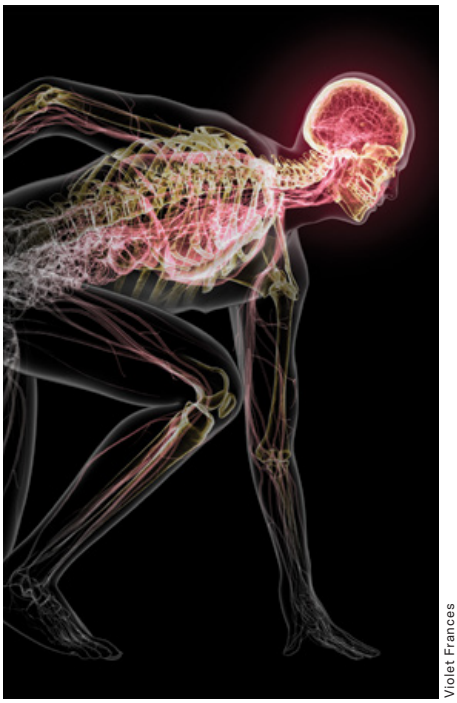

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THE SCIENCE OF THE TRUE YOU

New research links self-actualization to optimal creativity, well-being and self-transcendence BY SCOTT BARRY KAUFMAN

ON JUNE 8, 1970, Abraham Maslow was writing furiously in his notebook by the pool at his home in Menlo Park, Calif. For the past few years he had been working intensely on a new theory linking self-actualization to self-transcendence and spirituality. Suddenly his stopwatch went off, reminding him to do his daily exercise (after a recent heart attack, he had been on strict doctor's orders to exercise daily to strengthen his heart). With annoyance at being disrupted, he threw down his notepad and started jogging by the side of the pool. His wife, Bertha, was lounging nearby, and she noticed that he was moving in an odd fashion. Just as she started to ask him whether he was all right, Maslow collapsed. By the time she ran to his side, Maslow was dead at the age of 62, with a treasure trove of ideas and theories left behind and unrealized.

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“There is now emerging over the horizon a new conception of human sickness and of human health, a psychology that I find so thrilling and so full of wonderful possibilities…”
—Abraham Maslow,
Toward a Psychology
of Being

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Many people are familiar with Maslow's hierarchy of needs, in which he argued that basic needs such as safety, belonging and self-esteem must be satisfied (to a reasonable, healthy degree) before one can fully realize one's unique creative and humanitarian potential. What many people may not realize is that a strict hierarchy was not really the focus of his work (and in fact, he never represented his theory as a pyramid).

Especially later in his life, Maslow's focus was much more on the paradoxical connections between self-actualization and self-transcendence and on the distinction between defense and growth motivation. Maslow's emphasis was less on a rigid hierarchy of needs and more on the notion that self-actualized people are motivated by health, growth, wholeness, integration, humanitarian purpose and the "real problems of life."

As I explored Maslow's writings, I realized that the characteristics of self-actualizing people are even more relevant today than when they were first proposed nearly 70 years ago. It is clear that Maslow never conceptualized self-actualizing people as selfish or purely individualistic, despite such misrepresentation by some modern commenters. Instead. Instead Maslow became increasingly convinced that self-actualization is healthy self-realization on the path to self-transcendence.

Self-actualized people are motivated by health, growth, wholeness, integration, humanitarian purpose and the "real problems of life."

We live in times of widening divides, selfish concerns and individualistic pursuits of power. I fear Maslow's conceptualization of self-actualization and the vision of humanity that was prevalent among the humanistic psychologists of the 1960s and 1970s has been lost in this generation.

To help bring back these seminal ideas and integrate them into modern theory and research on well-being and personality, I combed through Maslow's writings and put his characteristics of self-actualization to the scientific test.

THE NEW "CHARACTERISTICS OF SELF-ACTUALIZATION" SCALE

AFTER SIFTING THROUGH Maslow's writings, I created an initial scale with 92 items spanning 17 characteristics of self-actualizing people. After rigorous testing, I found that 10 of Maslow's proposed characteristics of self-actualization stand up to scientific scrutiny. Not bad, considering his list was proposed nearly 70 years ago!* Without further ado, here are the 10 characteristics of self-actualization:

- *Continued freshness of appreciation* (Example: "I can appreciate again and again, freshly and naively, the basic goods of life with awe, pleasure, wonder and even ecstasy, however stale these experiences may have become to others.")
- *Acceptance* (Example: "I accept all of my quirks and desires without shame or apology.")
- *Authenticity* (Example: "I can maintain my dignity and integrity even in environments and situations that are undignified.")
- *Equanimity* (Example: "I tend to take life's inevitable ups and downs with grace, acceptance and equanimity.")
- *Purpose* (Example: "I feel a great responsibility and duty to accomplish a particular mission in life.")
- *Efficient perception of reality* (Example: "I am always trying to get at the real truth about people and nature.")
- *Humanitarianism* (Example: "I have a genuine desire to help the human race.")
- *Peak experiences* (Example: "I often have experiences in which I feel new horizons and possibilities opening up for myself and others.")
- *Good moral intuition* (Example: "I can tell 'deep down' right away when I've done something wrong.")

**Maslow did get one thing very wrong: he believed that self-actualization was extremely rare in the population, and he argued that it was virtually unattainable among young people. I found that this isn't true. Self-actualization scores conformed to a normal distribution, much like IQ or height. What's more, self-actualization was not correlated with age, education, race, ethnicity, college GPA or childhood family income, and there were no gender differences found in self-actualization. Although there are certainly environmental barriers to self-actualization, with different environments helping to bring out the best or the worst in us, I found no evidence that the characteristics of self-actualization are limited to a particular swath of humanity.*

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- *Creative spirit* (Example: "I have a generally creative spirit that touches everything I do.")

What interested me the most was the overall self-actualization factor. Any one of these characteristics viewed in isolation does not necessarily indicate a self-actualized person. But what do all these characteristics predict in the real world when they are viewed as a single unit?

SELF-ACTUALIZATION, HEALTH AND GROWTH

THE HUMANISTIC PSYCHOLOGISTS of the 1950s and 1960s—including Alfred Adler, Charlotte Bühler, Viktor Frankl, Erich Fromm, Karen Horney, Sidney Jourard, Rollo May and Carl Rogers—were not focused on happiness or achievement (topics that receive so much attention in modern-day psychology and in self-help books). Instead they were interested in the determinants of health and growth. I found an overall pattern suggesting that the characteristics of self-actualization lead to optimal health and growth.

Overall, self-actualization was related to higher levels of stability and the ability to protect your highest-level goals from disruption by distracting impulses and thoughts. Self-actualization was related to lower levels of disruptive impulsivity ("get out of control," "am self-destructive"), nonconstructive thinking ("have a dark outlook on the future," "often express doubts"), and a lack of authenticity and meaning ("feel that my list lacks direction," "act or feel in a way that does not fit me").

Just as Maslow predicted, those with higher self-actualization scores were much more motivated by growth, exploration and love of humanity than by the fulfillment of deficiencies in basic needs. What's more, self-actualization scores were associated with multiple indicators of well-being, including greater life satisfaction, curiosity, self-acceptance, positive relationships, environmental mastery, personal growth, autonomy and purpose in life.

There were also links to work performance and creativity—self-actualization predicted greater work satisfaction and work performance, as well as greater reports of talent, skill and creative ability across a wide range of fields from the arts and sciences to business and sports. Interestingly, there was a significant (but small) correlation between self-actualization and humor ability, which Maslow predicted would be the case (he often viewed humor ability as one of the defining characteristics of self-actualization).

The relation between self-actualization and self-transcendence was also very interesting. I used a scale developed by David Yaden of Johns Hopkins University and his colleagues, which measures two aspects of self-transcendence: decreased self-salience and increased feelings of connectedness. Although self-actualization showed zero relation to decreased self-salience, it did show a strong positive correlation with increased feelings of oneness with the world.

Self-actualization did show a strong positive correlation with increased feelings of oneness with the world.

This finding helps to reconcile a paradox that consumed Maslow in the last few years of his life: Why is it that the most self-actualized people are those who are the most self-transcendent? As he wrote in his 1961 paper "Peak Experiences as Acute Identity Experiences":

> The goal of identity (self-actualization ...) seems to be simultaneously an end-goal in itself, and also a transitional goal, a rite of passage, a step along the path to the transcendence of identity. This is like saying its function is to erase itself. Put the other way around, if our goal is the Eastern one of ego-transcendence and obliteration, of leaving behind self-consciousness and self-observation, ... then it looks as if the best path to this goal for most people is via achieving identity, a strong real self, and via basic-need-gratification.

Self-actualized people don't sacrifice their potentialities in the service of others; rather *they use their full powers in the service of others* (important distinction). You don't have to choose either self-actualization or self-transcendence—the combination of both is essential to living a full and meaningful existence.

For more on the details of the study, including more finely grained connections between self-actualization and the optimal functioning of a cybernetic, goal-directed system, as well as links with self-determination theory, read the full paper published in the January 2023 issue of the *Journal of Humanistic Psychology*. And don't forget to take the test! ●

Scott Barry Kaufman is a humanistic psychologist exploring the depths of human potential. He has taught courses on intelligence, creativity and well-being at Columbia University, N.Y.U., the University of Pennsylvania, and elsewhere. He hosts the *Psychology Podcast* and is author and/or editor of nine books, including *Transcend: The New Science of Self-Actualization, Wired to Create: Unraveling the Mysteries of the Creative Mind* (with Carolyn Gregoire), and *Ungifted: Intelligence Redefined.* Find out more at http://ScottBarryKaufman.com. In 2015 he was named one of "50 groundbreaking scientists who are changing the way we see the world" by *Business Insider.* He wrote the extremely popular Beautiful Minds blog for *Scientific American* for close to a decade. Follow him on X @sbkaufman

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OPINION

CREATING OUR

One brain region helps people maintain a consistent identity

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SENSE OF SELF

BY ROBERT MARTONE • ILLUSTRATION BY ZOE LIU

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WE ARE ALL TIME TRAVELERS. Every day we experience new things as we travel forward through time. As we do, the countless connections among the nerve cells in our brain are recalibrated to accommodate these experiences. It's as if we reassemble ourselves daily, maintaining a mental construct of ourselves in physical time, and the glue that holds together our core identity is memory.

Our travels are not limited to physical time. We also experience mental time travel. We visit the past through our memories and then journey into the future by imagining what tomorrow or next year might bring. When we do so, we think of ourselves as we are now, remember who we once were and envision how we will be.

A study published in 2021 in the journal *Social Cognitive and Affective Neuroscience* (*SCAN*) explores how one particular brain region helps to knit together memories of the present and future self. When people sustain an injury to this area, it leads to an impaired sense of identity. The region—called the ventromedial prefrontal cortex (vmPFC)—may produce a fundamental model of the person and place it in mental time. When the region does so, this study suggests, it may be the source of our sense of self.

Psychologists have long noticed that a person's mind handles information about oneself differently from other details. Memories that reference the self are easier to recall than other forms of memory. They benefit from what researchers have called a self-reference effect, in which information related to oneself is privileged and more salient in that person's thoughts. Self-related memories are distinct from both episodic memory, the category of recollections that pertains to specific events and experiences, and semantic memory, which connects to more general knowledge, such as the color of grass and the characteristics of the seasons.

Self-reference effects, then, are a way to investigate how our sense of self emerges from the workings of the brain—something that multiple research groups have studied intensely. For example, previous research employed functional magnetic resonance imaging (fMRI), a method that uses blood flow and oxygen consumption in specific brain areas as a measure of neural activity, to identify regions that were activated by self-reference. These studies identified the medial prefrontal cortex (mPFC) as a brain region related to self-thought.

This area, the mPFC, can be further divided into upper and lower regions (called dorsal and ventral, respectively), and it turns out that each one makes different contributions to self-related thought. The dorsal section plays a role in distinguishing self from other and appears to be task-related, whereas the ventral section, the vmPFC, contributes more to emotional processing.

In the *SCAN* study, the researchers used the self-reference effect to assess memories of present and future selves among people who had brain lesions to the vmPFC. The scientists worked with seven people who had lesions to this area and then compared them with a control group made up of eight people with injuries to other parts of the brain, as well as 23 healthy individuals without brain injuries. By comparing these groups, the scientists could investigate whether brain lesions in general or those to the vmPFC specifically might affect self-reference. All people in the study underwent a thorough neuropsychological evaluation, which confirmed that they were within normal ranges for a variety of cognitive assessments, including measures of verbal fluency and spatial short-term memory. The researchers then asked the participants to list adjectives to describe themselves and a well-known celebrity, both in the present and 10 years in the future. Later, the participants had to recall these same traits.

The researchers discovered that people in their control group could recall more adjectives linked to them-

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selves in the present and future than adjectives linked to the celebrity. In other words, scientists found that the self-reference effect extends to both the future and the present self. Although there was some variation in the group—people with brain injuries to areas other than the vmPFC were somewhat less able to recall details about their future self compared with noninjured participants—the self-reference effect still held true.

Results were distinctly different, however, for the participants with injuries to the vmPFC. People with lesions in this area had little or no ability to recall references to the self, regardless of the context of time. Their identification of adjectives for celebrities in the present or future was also significantly impaired compared with the rest of the participants' responses. In addition, people with vmPFC lesions had less confidence about an individual's ability to possess traits than other people in the study. All of this evidence points to a central role for the vmPFC in the formation and maintenance of identity.

These findings are intriguing for several reasons. Brain lesions can help us understand the normal function of the region involved. Lesions of the vmPFC are associated with altered personality, blunted emotions, and a number of changes in emotional and executive function. Injury to this area is most often associated with confabulations: false memories that people recite to listeners with great confidence. Although it may be tempting for someone to view confabulations as deliberate or creative falsehoods, people who tell them actually are unaware that their stories are false. Instead it is possible their confusion could stem from misfunctioning memory retrieval and monitoring mechanisms.

More broadly, the study helps us understand how self-related memories—recollections key to maintaining our core sense of identity—depend on the function of the vmPFC. But what about our past selves? Curiously, in previous studies that asked people to consider their past selves, there was no more activation of the mPFC than when considering someone else. Our past selves seem foreign to us, as if they were individuals apart from us.

One idea that scientists have put forward to understand this distinction is that perhaps we are not very kind in our judgments of our past selves. Instead we may be rather critical and harshly judgmental of our previous behavior, emotions and personal traits. In these situations, we may use our past primarily to construct a more positive self-image in the present. Put another way, because we may recognize flaws in our past self's behavior, we tend to distance ourselves from the person we once were.

Bringing the present and future into the spotlight, then, is central to understanding the way our brain and thoughts shape our current identities. In many ways, it makes sense that the mPFC is key in this process of recalling present details and imagining future ones that build on our memories. The prefrontal cortex, including the mPFC and its subdivisions, forms a network in the brain that is involved in future planning.

That network also includes the hippocampus, a brain structure that is central to episodic memory formation and that can track moments as sequential events in time. In earlier work, researchers found that manipulating the activity of the hippocampus alters creative and future imaginings, which suggests an important role for brain structures supporting memory in imagining the future. In fact, although we often think of memory as the brain's accurate and dispassionate recording device, some scholars have characterized it as a form of imagination.

Our past selves seem foreign to us, as if they were individuals apart from us.... Because we may recognize flaws in our past self's behavior, we tend to distance ourselves from the person we once were.

Future thought is a vital component of being human. Its importance in our culture is embodied in the mythological figure and pre-Olympian god Prometheus (whose name means "fore-thinker"), patron of the arts and sciences. According to Greek legend, he shaped humans out of clay and bestowed them with fire and the skills of craftsmanship. These are acts that illustrate the power of imagining a novel future. Although there is debate as to whether thinking about the future is an exclusively human feature—birds such as Western Scrub-Jays, for example, appear to anticipate and plan for future food needs—it is clear that future thought has played a significant role in human evolution. This ability may have contributed to the development of language, and it has a key part in human interactions, where the vmPFC is central to evaluating and taking advantage of social context.

Now, thanks to this research, we have a better idea than ever about the way a small region within our brain is able to build and hold this core ability to maintain our identity. ●

Robert Martone is a research scientist with expertise in neurodegeneration. He spends his free time kayaking and translating Renaissance Italian literature.

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IN DEFENSE OF THE PSYCHOLOGICALLY RICH LIFE

It involves complex mental engagement; a wide range of deep, intense emotions; and diverse, novel and interesting experiences

BY SCOTT BARRY KAUFMAN

WHAT DOES IT MEAN to live a good life? This question has been debated and written about by many philosophers, thinkers and novelists throughout the course of humanity. In the field of psychology, two main conceptualizations of the good life have predominated: A *happy life* (often referred to as "hedonic well-being"), full of stability, pleasure, enjoyment and positive emotions, and a *meaningful life* (often referred to as "eudaimonic well-being"), full of purpose, meaning, virtue, devotion, service and sacrifice. But what if these aren't the only options?

In recent years a long-neglected version of the good life has been receiving greater research attention: the *psychologically rich life*. The psychologically rich life is full of complex mental engagement; a wide range of intense and deep emotions; and diverse, novel, surprising and interesting experiences. Sometimes the experiences are pleasant, sometimes they are meaningful, and sometimes they are neither pleasant nor meaningful. They are rarely boring or monotonous, however.

After all, both happy and meaningful lives can become monotonous and repetitive. A person with a steady job who is married with children may be generally satisfied with their life and find many aspects of it meaningful and still be bored out of their mind. And the psychologically rich life doesn't necessarily involve economic riches. Consider novelist Hermann Hesse's character Goldmund, who has no money but pursues the life of a wanderer and a free spirit.

Recent research on psychological richness has found that it is related to, but partially distinct from, both happy and meaningful lives. Psychological richness is much more strongly correlated with curiosity, openness to experience, and experiencing both positive and negative emotions more intensely. But is the psychologically rich life one that people actually want?

In a 2020 study, Shigehiro Oishi of the University of Chicago and his colleagues proposed that psychological richness is a neglected aspect of what people consider a good life and set out to assess how much people around the world actually desire such a life. The researchers asked people living in nine diverse countries the degree to which they value a psychologically rich life, a happy life and a meaningful life.

They found that many people's self-described ideal life involves psychological richness. When forced to choose a life, however, most chose a happy life (ranging from 49.7 to 69.9 percent) and a meaningful life (14.2 to 38.5 percent). Even so, a substantial minority of people still favored the psychologically rich life, ranging from 6.7 percent in Singapore to 16.8 percent in Germany.

These numbers went up when the desire for a psychologically rich life was measured *indirectly*. To fully understand what a person wishes their life might have been, it is important to explore what people wish they had avoided in their life. Therefore, Oishi and his colleagues asked people what they

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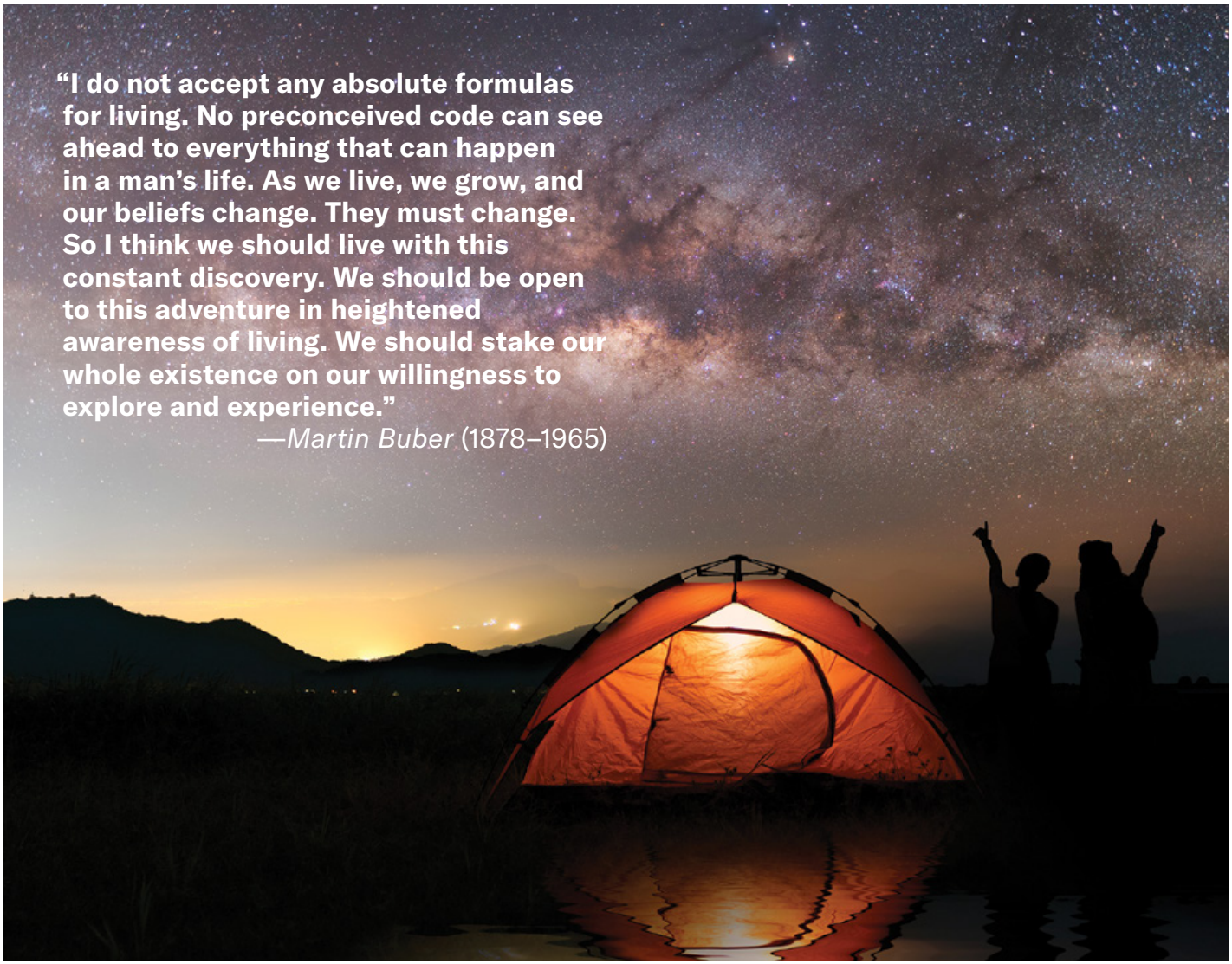
"I do not accept any absolute formulas for living. No preconceived code can see ahead to everything that can happen in a man's life. As we live, we grow, and our beliefs change. They must change. So I think we should live with this constant discovery. We should be open to this adventure in heightened awareness of living. We should stake our whole existence on our willingness to explore and experience."
—Martin Buber (1878–1965)

Sarote Pruksachat/Getty Images

regret most in their life and whether undoing or reversing this regrettable life event would have made their life happier, more meaningful or psychologically richer.

They found that about 28 percent of Americans said that undoing the regrettable event would have made their life psychologically richer. For instance, one person wrote that they regretted "not going to a four-year college to get a degree. I feel like I missed out on some interesting experiences." In Korea, the percentage was even higher, with 35 percent of participants saying that undoing the regrettable event would have made their life psychologically richer compared with happier (27.6 percent) or more meaningful (37.4 percent).

These findings suggest that although most people do strive to be happy and have meaning and purpose in their life, a sizable number of people are content merely living a psychologically rich existence. Indeed, other research suggests that for a lot of people, the *intensity* of the experience matters more than merely how "positive" or "negative" it was. As Oishi and his colleagues conclude, "we believe that taking the psychologically rich life seriously will deepen, broaden, and, yes, *enrichen* our understanding of well-being."

At the end of the day, there is no one singularly acceptable path to the good life. You have to find a path that works best *for you*.

As philosopher Friedrich Nietzsche put it, "no one can build you the bridge on which you, and only you, must cross the river of life. There may be countless trails and bridges and demigods who would gladly carry you across; but only at the price of pawning and forgoing yourself. There is one path in the world that none can walk but you. Where does it lead? Don't ask, walk!"

Nietzsche also noted, though, that it is "an agonizing, hazardous undertaking thus to dig into oneself, to climb down roughly and directly into the tunnels of one's being."

If you dig deep into the tunnels of your being and realize that the best path for you is to live a life full of rich and complex ideas, emotions and experiences (which sometimes can be negative but ultimately conducive to growth), then I hope this research shows you that this is not necessarily a lonely path. There are plenty of people in the world who crave the psychologically rich life and who even prioritize novelty, variety, complexity, intensity, depth and surprise in their daily life. ●

Scott Barry Kaufman is a humanistic psychologist exploring the depths of human potential. He has taught courses on intelligence, creativity and well-being at Columbia University, N.Y.U., the University of Pennsylvania, and elsewhere. He hosts the *Psychology Podcast* and is author and/or editor of nine books, including *Transcend: The New Science of Self-Actualization*, *Wired to Create: Unraveling the Mysteries of the Creative Mind* (with Carolyn Gregoire), and *Ungifted: Intelligence Redefined*. Find out more at http://ScottBarryKaufman.com. In 2015 he was named one of the "50 groundbreaking scientists who are changing the way we see the world" by *Business Insider*. He wrote the extremely popular Beautiful Minds blog for *Scientific American* for close to a decade. Follow him on X @sbkaufman

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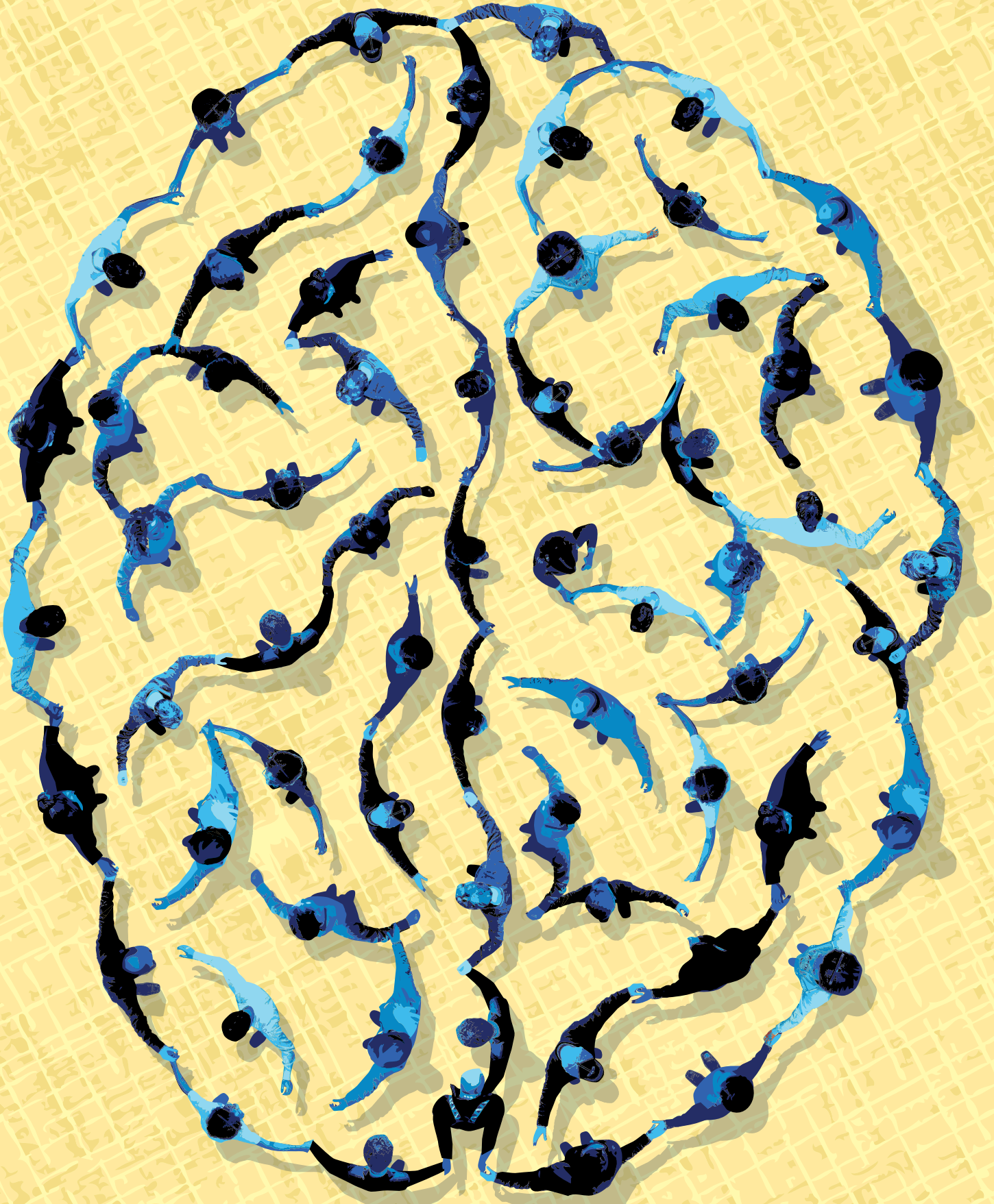

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CREATIVITY IS COLLECTIVE

Personal experiences and character traits alone may not be enough to produce a prodigy. It takes a village

BY S. ALEXANDER HASLAM,
INMACULADA ADARVES-YORNO
AND TOM POSTMES
ILLUSTRATION BY DANIEL HERTZBERG

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THE BEST ACTORS, directors and screenwriters receive Oscars; the top scientists, Nobel Prizes. Society doles out a multitude of awards every year to celebrate the creative achievements of individuals. Such events feed a popular conception that creativity is a gift only certain people possess and constitutes the apotheosis of individuality. Albert Einstein once observed, "Everything that is really great and inspiring is created by the individual who can labor in freedom." In these terms, the straitjacket of groups and of mainstream society is often thought to spell death for creativity. Many see the notion of group creativity as an oxymoron.

But let us think creatively here and challenge the basic assumption that the individual creator is the only critical component of the creative process. Indeed, let us consider the possibility that groups play an essential role in creativity—not only in generating and shaping novel products but also in ensuring their appreciation and impact. Although this idea might seem preposterous, it has garnered significant scientific support. The three of us, with our colleague Lise Jans, published a review of much of the accumulated data in an article summarizing the thinking about groups and creativity. We concluded that it is problematic and unhelpful to separate the creativity of individual minds from the communities in which they flourish.

SOCIAL IDENTITIES

DESPITE THE ROMANTIC notion that innovation is the province of rugged individuals toiling away in splendid isolation, a scientific focus on individual personality has not yet yielded accurate forecasts of creative behavior. Scholars have scoured the biographies of creative geniuses to find experiences and character traits likely to have contributed to their greatness. Yet they have failed to identify characteristics that powerfully predict which young people will go on to become creative geniuses.

These efforts lack predictive power because they do not take into account the important role that social context plays. The nature and significance of innovation depend on the interaction between an individual's ideas and the time and culture in which that person lives. If Bruce Springsteen had been born in 1749 rather than 1949, we would have been unlikely ever to hear *Born to Run*. Likewise, if Italian composer Domenico Cimarosa had been born in 1949 rather than 1749, his nearly 80 operas, including the masterpiece *Il matrimonio segreto,* probably would not have seen the light of day.

Such examples speak more generally to the influence that groups exert on creativity. In the 1970s psychologists Henri Tajfel and John Turner of the University of Bristol in England developed the concept of social identity, noting that across a range of contexts, people understand themselves not only as individuals but also as members of the groups to which they belong. So a cubist painter—we'll call him "Pablo"—may sometimes think of himself in terms of his personal identity (Pablo), but on other occasions he will understand himself as a cubist, his social identity. In yet other situations, his social identity might be defined with reference to his nationality, gender or religion or to his role in a specific team, club or organization.

Tajfel and Turner argued that when a particular social identity is psychologically salient, such that it determines a person's sense of who they are, the group that is the basis for that identity will exert a profound influence on that individual's behavior. Furthermore, the way in which that person evaluates an action, regardless of whether it is their own, will reflect shared understandings of that group. This idea also applies to creative behavior and its evaluation. For example, as a cubist, Pablo is more likely to be interested in and to appreciate abstract representations of objects, and he will be more likely to paint in accordance with cubist guidelines and preferences.

Social identities also grant people a shared perspective, as well as the ability and motivation to engage in

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mutual social influence. But when people act in terms of their unique personal identity, they are likely to display creativity by deviating from the norm. In an experiment published in 2007, the three of us asked some groups of college students to create posters about "reasons for going to university" and others to make posters about "fashion at university." With these instructions, we implicitly led the students toward certain group norms. Those told to focus on "reasons" naturally made posters dominated by words, and those directed toward "fashion" created posters populated largely by images.

In a second phase of the study, which came three hours later, we asked the same participants to create a leaflet to advertise the university, a task that could be accomplished equally well with words as with pictures. This time some of the students worked in groups, whereas others made the leaflet on their own. Here we were interested in whether this creative task would be shaped by the group norm that had been established in the earlier phase. It was. We found that when working in a group, participants' creations were generally in line with the group norm established during the poster-making project, whether it centered on images or words. When working individually, however, participants typically departed from the norm of the group they had previously belonged to. Such findings, and those of similar studies, support the claim that the nature of people's creative activity depends on group norms.

Musical groups—such as the Beatles (*above*)—as well as groups of writers, scientists, and others, can fuel creativity when group members receive encouragement and constructive feedback from one another.

Even radical efforts to depart from the mainstream, such as those that were promulgated by punk rock band the Sex Pistols (*above*), get much of their momentum from the culture they reject.

COLLABORATIVE SPIRIT

EVIDENCE THAT SOCIAL identification shapes creativity might suggest that groups simply stimulate convergent thinking and conformity. Indeed, back in the 1970s, Irving Janis of Yale University proposed that a desire to conform to the group leads to a lack of critical thinking and faulty decision-making—a phenomenon called groupthink that he considered the antithesis of creativity. But although group dynamics can sometimes be stifling (or worse), they do not inevitably produce irrational choices or unquestioning support of the group's ideas.

For one thing, group standards shape only one facet of an individual's creativity. Cubist painters, for instance, may use abstract geometric figures in line with the customs of cubism, but their artwork is likely to diverge on other dimensions—for example, in its use of certain colors or themes—that are not restrained by the cubist style.

In addition, far from repressing new ideas, collaborative discussions with friends, colleagues or peers can foster them. As the late psychologist Vera John-Steiner of the University of New Mexico noted in her 2000 book *Creative Collaboration,* small groups—the Beatles, Bauhaus or the Bloomsbury Group, for instance—routinely spearhead innovation by bouncing ideas off one another as they look for new ways to tackle artistic, theoretical and practical problems.

What is more, solidarity and conformity are essential for creative movements to progress because they

Michael Ochs Archives/Getty Images (*top*); Bettmann/Getty Images (*bottom*)

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allow individuals to cohere around a shared enterprise. In a study published in 2006, we explored this idea by asking small groups of college students to participate in a mock planning process directed at the building of an innovative municipal childcare center. Prior to the study, some of the groups went through a procedure that instilled a strong sense of shared social identity, whereas other groups were encouraged to think of themselves as individuals. The groups then met three times over an hour and a half to discuss the fictitious project, which encountered mounting difficulties. First, labor costs increased, and then an environmental impact study was needed. Next, they learned that the children's sandbox had traces of toxic elements, parents were threatening to sue, and officials were holding up building approval.

We found that the groups that had initially developed a shared social identity stayed upbeat about the project and continued to support it even as it ran into trouble. In contrast, those coaxed to see themselves as individuals lost their enthusiasm for the childcare center and increasingly argued to abort the project as time went on. In other words, social—but not personal—identity bolstered enthusiasm and encouraged people to stay with the creative task in the face of challenges. More generally, people seem to need a sense of shared social identity to stick to their creative guns and see revolutionary projects—whether in science, industry, the arts or politics—to completion.

Being solidly committed to the group does not make a person oblivious to its faults, either. Sometimes the opposite appears to be the case. When norms are harmful for a group, it is actually the members who feel most connected to the group who are the most motivated to debate and renegotiate those norms. In research published in 2012, psychologists Dominic J. Packer of Lehigh University and Christopher T. H. Miners of Queen's University in Ontario asked students to write an opening statement before a meeting in which they were going to discuss alcohol use with their peers, among whom a tendency to party was the norm. The researchers found that the more the participants identified with the group, the more their statements involved creative challenges to that group norm, possibly because those high identifiers felt the greatest responsibility to the group or the most able to effect a transformation. Either way, the research shows that engagement with groups can help stimulate creative ideas for change.

Pablo Picasso (*above*) likely thought of himself as a cubist painter as well as an antifascist and a Spaniard. Depending on the context, different social identities will influence our behavior.

GETTING ATTENTION

GROUPS ALSO PLAY a vital role in the appreciation of groundbreaking achievements. Without tapping into group identity, innovative artists, writers and scientists may well go unrecognized. In his lifetime, Vincent van Gogh could find hardly anyone to buy his unusual paintings. His work garnered attention only when, after his death, a circle of artists, the Postimpressionists, saw his paintings as indicative of a distinctive style that they wanted to emulate in their own work. Similarly, in 1961 the computational models of then graduate student Yoshisuke Ueda were initially barred from publication by his supervisor at Kyoto University because they were seen to be too avant-garde. Once a community of scientists had formed who appreciated Ueda's work, however, his theories transformed the newly emerging field of chaos theory.

Indeed, people are far more likely to support a creative project or endeavor if its instigator is a member of their group. Such insider status helps to dispel the uncertainty that new products introduce by disrupting the status quo. Insiders in organizations are typically antagonistic toward outsiders' contributions, and people often display ethnocentric bias when judging artistic creativity as well. In the performing arts, judges may preferentially bestow accolades on citizens of their own country.

For example, both the U.S. Oscars and the British Academy of Film and Television Arts (BAFTA) awards are meant to judge the objective quality of films. But in an archival study published in 2017 in the *British Journal of Psychology,* psychologist Niklas Steffens and his colleagues at the University of Queensland in Australia found that since 1968, U.S. actors and actresses have received about 80 percent of the Oscars for best actor and best actress but less than half of the BAFTA awards for the same categories. At the same time, British performers have received nearly half the BAFTA awards for best actor or actress but only slightly more than 10 percent of the corresponding Oscars.

Experiments confirm that people's perceptions of creativity depend on whether the creator is "one of us" or "one of them." In one study published in 2008, the

When norms are harmful for a group, it is the members who feel most connected to the group who are the most motivated to debate and renegotiate those norms.

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three of us asked 50 people from the U.K. to evaluate suggestions about the future format of a television show that we said had come from a British website. We told another 50 participants that the same ideas had come from a Dutch website. In part two of the study, we asked 125 British students to evaluate works of art that we attributed to either British or Dutch college students. In both cases, participants who thought their fellow Brits, the in-group, had authored the products in question judged them to be significantly more creative than did those told that Dutch citizens had generated the same items.

Even the most creative people need followers. The art of painter Vincent van Gogh (*self-portrait above*) received widespread recognition only after his death, when it inspired a burgeoning group of artists, the Postimpressionists.

What people actually mean by creativity—and hence how they measure and reward it—also depends on cultural identity. In work published in 2008, psychologists Susannah Paletz, now at the University of Maryland, and Kaiping Peng of the University of California, Berkeley, conducted a survey that included more than 300 students from China and the U.S. to find out what they thought made certain products creative. They tested two very different types of products: a course textbook and a meal cooked by a friend. They found that American students' judgments of creativity were swayed more by the perceived appropriateness of a product (whether it was, in some sense, good), whereas the judgments of Chinese students were based more on whether the product was something they personally desired. The Americans thus saw creativity more as a matter of taste, and the Chinese saw it more as a matter of appetite.

The tendency for creativity judgments to reflect our social identities also explains some gender bias. In a 2006 paper, psychologist Thomas Morton of the University of Copenhagen and his colleagues reported that male scientists viewed theories explaining how men were superior to women to be better and more creative than those arguing that women were superior to men. This pattern was reversed for female scientists. Both groups also believed that the creative research that supported their own identity-based preferences was deserving of more research funding.

For their part, good creators have a strong sense of their audience and gear their solutions or products to the perceived needs and values of a particular group. Even when work is inspired by the need to separate from a group, successful creators are familiar with the group from which they wish to deviate.

For example, in the 1970s punk rock bands such as the Sex Pistols wanted to break away from mainstream popular music. Sid Vicious, the bassist for the group, called on people to "undermine [the establishment's] pompous authority, reject their moral standards, make anarchy and disorder your trademarks." Ironically, then, the musical establishment of the time gave his band a particular creative force (the desire to rebel), as well as a specific trajectory (something specific to move away from) and appeal (for those disaffected with mainstream popular music). Accordingly, as with other successful creative efforts, the attempts by the Sex Pistols to break the mold were not quite so random and anarchic as their progenitors would have us believe.

TRANSFORMING COMMUNITIES

AS MEMBERS OF GROUPS, people engage in creative behavior and evaluations of others' innovations that reflect a desire to extend the values of those groups and to challenge the values of outsiders. To be celebrated rather than vilified, innovators need to know the norms they are departing from. Eventually they also need an audience willing to embrace the new ways of seeing or behaving made possible by their work. To meet with success, therefore, creative endeavors must transform communities. These newly formed audiences then drive the cultural change that novel endeavors spark.

Popular thinking on this topic, however, hews closer to Pablo Picasso's. "Disciples be damned," he once said. "It's only the masters that matter. Those who create." Yet as the curators of a major exhibition at London's National Gallery noted in 2009, Picasso's own work owed much to earlier modes of painting that he eventually rejected, and without admirers his work would have had little influence on society. His work was therefore not about laboring on his own to create everything anew. Rather as Welsh painter Osi Rhys Osmond, who died in 2015, put it in a review of the exhibition, it was a collaborative exercise in "reinventing the familiar."

We should still study and celebrate the creative genius of individuals. Nevertheless, we need to recognize that the psychology of creativity also involves the groups in which creators develop their work, whose boundaries they seek to extend and through which they have their sway. "I did it my way" may be an appealing anthem for great creators, but as with Frank Sinatra, their success generally also requires promoters, producers and an approving public. ●

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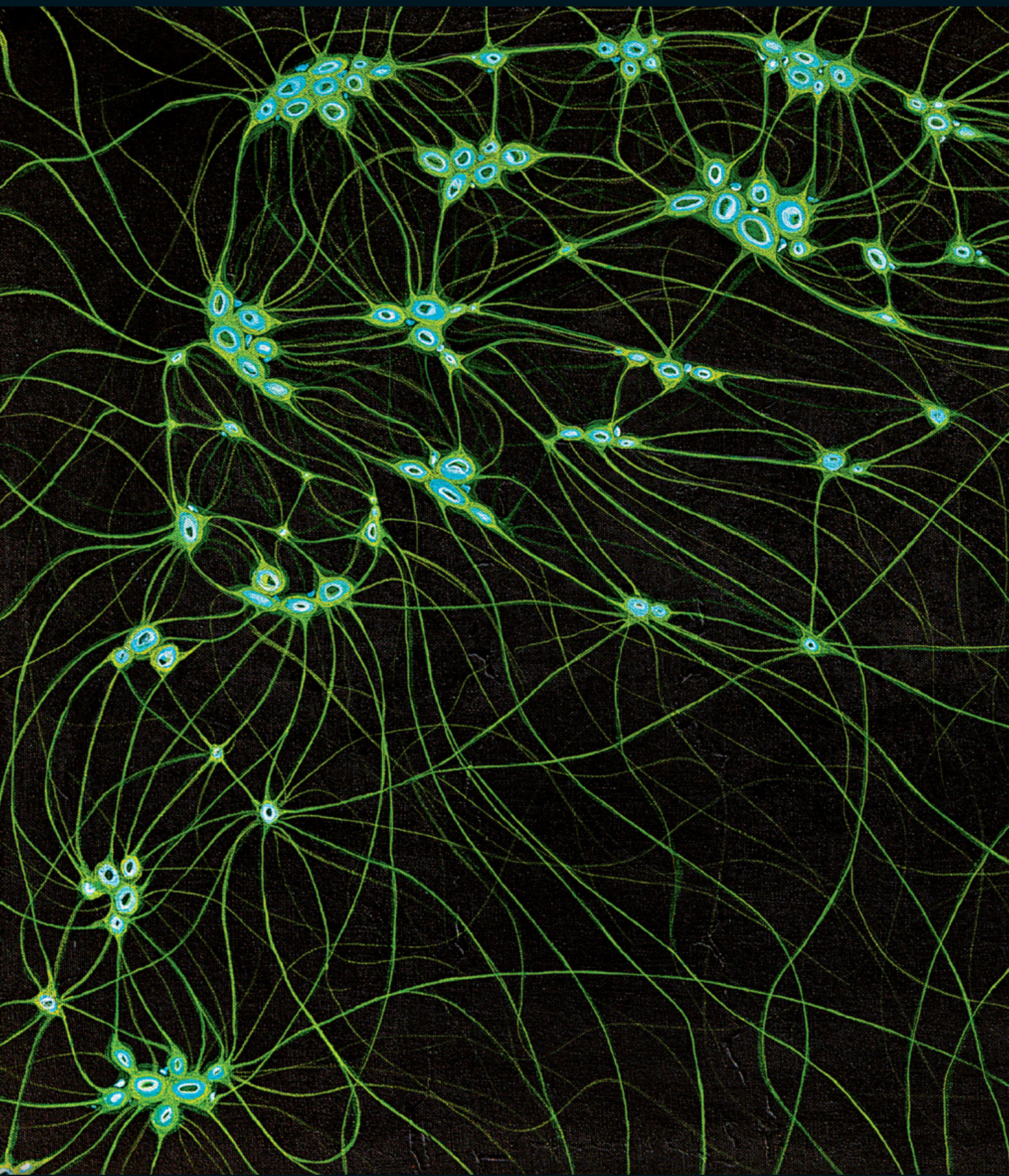

Painting by Nessa Bryce

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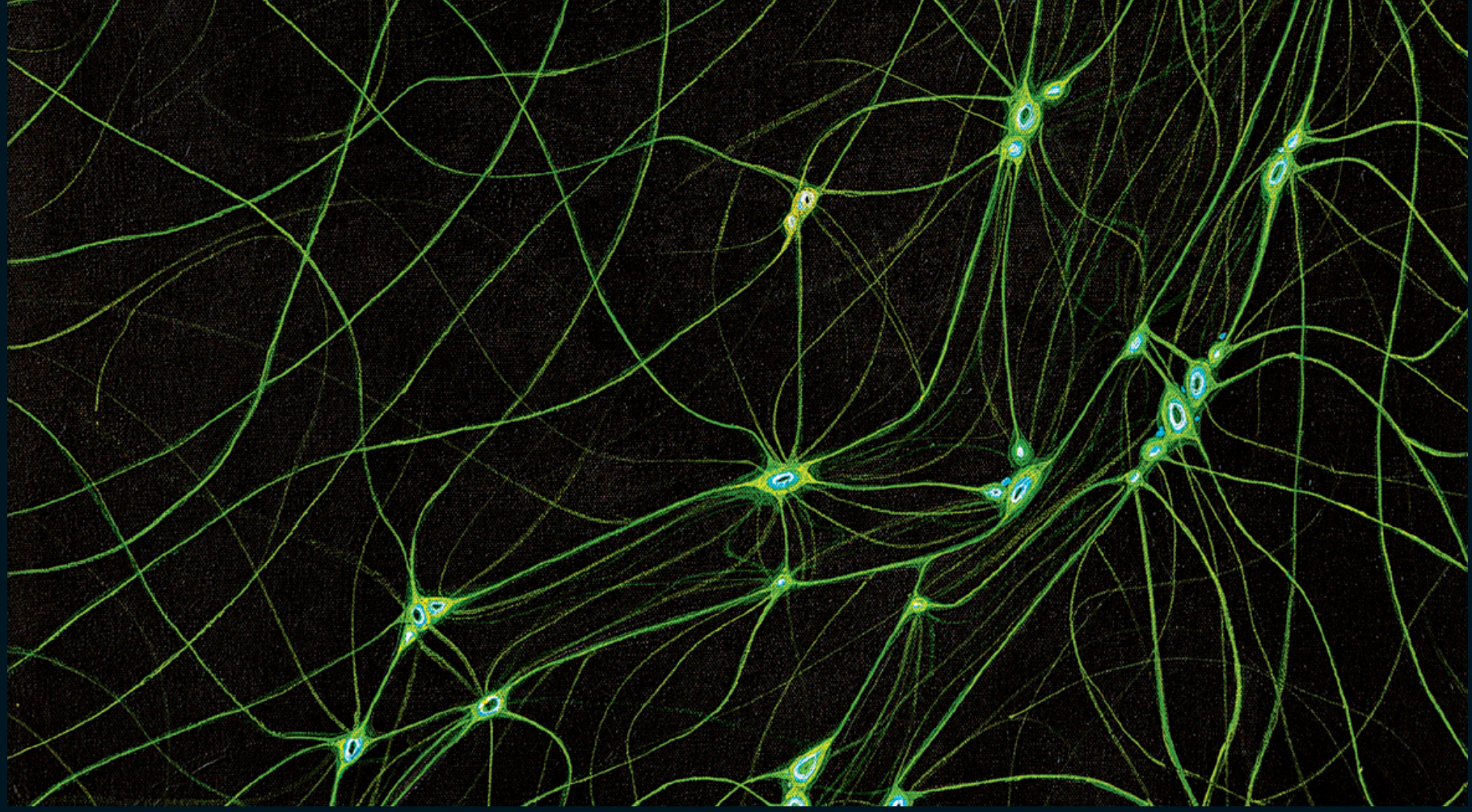

THE AHA! MOMENT

A step-by-step guide to your next creative breakthrough

BY NESSA BRYCE

ILLUSTRATIONS BY COLIN HAYES

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TAKE A MOMENT to look at the image on the preceding pages. What do you see? Just a neural network? Perhaps you spotted the hidden figure. If so, you have just had a moment of insight. You may have felt a similar jolt when discovering the solution to a math problem, understanding a joke or metaphor, or realizing something unexpected about yourself. These aha! moments occur when your brain spontaneously reinterprets information to reach a novel, nonobvious conclusion.

I painted *Neurons* about a decade ago for an art exhibit. I had designed the piece to portray the idea that our brain's neural networks make us who we are. It was only after joining psychologist James T. Enns's vision laboratory at the University of British Columbia in 2013 that I had my own abrupt realization: I recognized how my art could inform science. Using this piece, along with other hidden-object images, I investigated how an individual's focus and attention change when the person is experiencing an unexpected revelation.

For centuries creative individuals have described their sudden breakthroughs, instances when they are able to recombine information in a new and useful way. Scientists view these flashes of insight as markers of the creative process—and observing them in the laboratory elucidates what happens in the brain during problem-solving.

"A story is emerging about all the factors that lead up to an insight," says cognitive psychologist John Kounios, who studies creativity at Drexel University.

What researchers are finding is that the contemporary science of creativity largely bolsters an almost century-old theory. In 1926 political scientist Graham Wallas defined the creative process as four distinct stages: preparation, incubation, illumination and verification. Since then, scientists have broken some of his stages into substages to reveal distinct cognitive processes. For example, preparation now consists of two parts, one involving general learning and the other more focused on skill building.

"These stages really seem to be universal, whether you are a scientist, artist, writer or musician," says Harvard University psychologist Shelley Carson, who has interviewed more than 1,000 creative individuals for her research. And creativity is not restricted to a subset of highly talented artists and thinkers, Carson says. These innovative individuals have a distinct style of thinking, and breaking down their approach can allow anyone to re-create the process. Brain research has revealed that we can all get closer to achieving that magical spark of insight with the help of a few simple techniques.

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STAGE 1: EXPLORE

Roughly speaking, people solve problems in one of two ways: either they tend to rely on moments of insight, or they prefer to approach things analytically. Answering questions with analysis involves finding solutions through deliberate, methodical trial and error, whereas insight is perceived as an abrupt epiphany. Both methods are useful, but insight is typically seen as the best option for "out of the box" solutions.

In 2008 Kounios and his colleagues monitored the brain activity of 26 study participants using electroencephalography (EEG) while they sat quietly in a room. After recording these electrical signals, the researchers asked the participants to try to solve 180 anagram problems, which involved reorganizing a word, such as "west," to form another word, such as "stew." Subjects also reported whether they had used an insightful or analytical approach to solve each problem.

Kounios found that the brain activity of people who used insight differed significantly from that of people who preferred the analytical approach. Before they even began solving problems, most members of the insight group exhibited less activity in the occipital lobe, a region involved in visual processing, compared with the analytical set.

Specifically, the brains in the insight group showed less activity in the so-called alpha-wave range, which reflects neural inhibition, and the beta-1-wave range, which is linked with selective visual attention. In other words, these findings suggest that people who rely on insight tend to experience diffuse visual attention when not actively engaged in a task.

This study, along with Carson's reports from highly creative individuals, suggests that to prime your brain for creativity, you should first wander the world with an open mind. "Gathering a broad base of knowledge is the first stage of the creative process, which usually comes naturally to people through intellectual curiosity," Carson says. Another way to break your thought habits is by asking questions such as "How can I do this differently?" and by stepping outside your comfort zone. A poet with writer's block, for example, might be advised to take up a new hobby such as scuba diving or dance lessons. Neuroscientist-turned-artist Greg Dunn discovered an entirely different way to depict the brain when he began studying Sumi-e art, an Asian style of painting. His experimentation with the style's free-flowing ink led to a simple yet elegant new method for painting neurons.

Yet simply exposing yourself to new things does not seem to be the full story. According to a study published in early 2018 by Sergio Agnoli and his colleagues at the Marconi Institute for Creativity at the University of Bologna in Italy, how you engage thoughts that arise through new experiences is important for facilitating creativity. They found that individuals who can deliberatively engage in focused mental exploration come up with more original solutions to problems than those who report little ability to control how their mind wanders. Therefore, building a solid foundation from which creativity can grow requires both exposing yourself to new experiences and intentionally engaging with the thoughts and feelings that arise as a result.

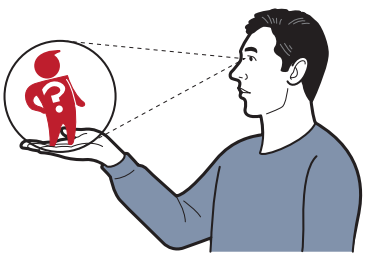
STAGE 2: FOCUS

Psychologist Dean Keith Simonton of the University of California, Davis, has linked creativity with the acquisition of expertise. In 2000 Simonton compared the cumulative years of experience of 59 opera composers with their aesthetic success. He measured aesthetic achievement in eight different ways—tallying the number of times an opera w-as recorded and performed in major opera houses, for example, as well as the number of pages devoted to the work in published opera histories.

Simonton found that a composer's years of musical experience were a powerful predictor of an opera's acclaim. He also found that if the composer had already created a number of other works within the same genre, this would actually hurt the opera's critical reception and legacy. In other words, solutions to great problems demand practice, skill and study, yet creative solutions occur when someone applies their experience to new domains.

Whether you are proving Fermat's last theorem or planning a birthday party, finding novel solutions involves a little advance research. How much preparation you need will vary, but the more you know about a problem, the better equipped you will be to solve it.

Some of the most creative minds in history were masters of their respective fields. Considering that these individuals spent large amounts of time immersed in their studies, one of the best ways to maximize your creativity is to find an area in which you would like to develop some expertise. Then begin to follow that passion.



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STAGE 3: INCUBATE

Once you have immersed yourself in a problem, the best way to come up with a creative solution is to stop consciously thinking about it. In 2006 Kounios and his colleagues used functional magnetic resonance imaging (fMRI) to record the brain activity of 44 people as they solved 185 remote-association problems. These word puzzles require finding a single word that can turn three seemingly unrelated words into familiar compound phrases; for example, the solution to "foam," "deep" and "salt" is "sea." After finding an answer, the subjects reported whether they had solved the problem using insight or analysis.

Kounios found that in the two seconds before a problem appeared, the insight users prepared for the challenge by shifting from their scattered outward attention to an inward focus. Puzzles solved insightfully were preceded by increased activation in the anterior cingulate cortex, a brain region that monitors internal attention to different ideas, among other things. In contrast, tasks solved analytically were preceded by significant activation in the occipital lobe, which, as mentioned earlier, handles visual processing. This increase indicates that the analytical solvers concentrated more on what they were looking at.

Research from the University of Amsterdam and the University of Bologna in Italy has demonstrated that sleeping on a problem or stepping away from it and then immersing yourself in an alternative activity can help you unconsciously cultivate creative solutions.

Taken together, the findings reveal a benefit to forcing your brain to shift gears or look within. One reason might be that your attention can then be captured by a surprising solution your unconscious mind has been ruminating on. So take a nap or try your hand at something new.

History is replete with examples of creative individuals who describe being hit with inspiration while daydreaming or attending to a different task. Writer Robert Louis Stevenson and musician Paul McCartney, for instance, used dreams as starting points for new works. Many day-to-day problems can be solved this way, which explains why so many people recall stumbling on ideas while taking a shower, driving to work or simply walking down the road.

STAGE 4: INSIGHT

When insight hits, certain changes happen in the brain. Psychologist Mark Beeman of Northwestern University led a study in 2004 that measured people's brain activity with fMRI and EEG during the moment of insight. As in Kounios's studies, participants tackled remote-association problems and then indicated whether they had cracked the problem by using insight. The results showed significantly increased activity in the anterior superior temporal gyrus of the right hemisphere at the critical moment when the solution appeared, in comparison to problem solvers who did not experience such an aha! moment. This gyrus is a prominent ridge on the cortex of the right hemisphere and plays a fundamental role in recognizing distant connections between words.

The activity surge in the right but not the left lobe may also be meaningful. According to the researchers, there are areas in the right side of your brain that interpret information more loosely than areas in the left side. This means that the infor-

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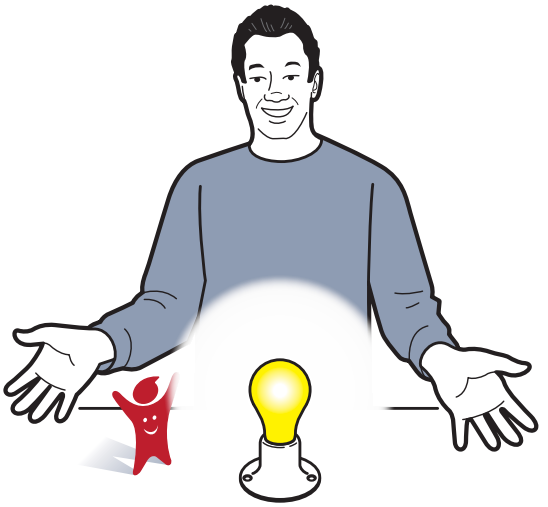
mation is less tightly defined, allowing you to access other concepts more readily, which is a key component of creativity. Both hemispheres are working all the time, but parts of your right hemisphere might loosely define a cat as a mammal, making it easy to see how a cat relates to, say, an elephant. Parts of your left hemisphere, however, might describe a cat as a small, carnivorous mammal with soft fur, a short snout and retractile claws—something very different from an elephant.

Research has suggested that you can tip the scales toward a looser style of understanding by describing objects or issues in unusual ways. For example, by thinking of a hanger as a long, twisted wire instead of as a metallic instrument for hanging coats, you might discover other uses for it. Try this technique every so often as you are actively working to solve your problem. It might help prime your brain to forge connections between distant concepts.

The moment of insight is also accompanied by a burst of alpha activity in the visual cortex, according to Beeman's study. Alpha activity, as mentioned earlier, inhibits neuron firing, meaning that during a breakthrough, your brain is less involved in processing visual information—perhaps because visual stimuli can be distracting. These findings suggest that you could help your brain discover an insight simply by closing your eyes.

Probably the most famous moment of insight in history is Archimedes' "Eureka!" Legend has it that the ancient Greek mathematician had been challenged to figure out whether a crown that King Hiero II of Syracuse had commissioned was made out of solid gold. Archimedes was preparing a bath when he discovered how to measure an object's volume, and thus its density, after noticing the displacement of water as he climbed into the tub. Although the story may be apocryphal, it has gone down in history in part because it illustrates perfectly how insight strikes.



STAGE 5: FOLLOW-THROUGH

Once you have had a moment of insight, you might find yourself feeling elated. A 2013 study by Tufts University researcher Tad Brunyé showed that subjects who came up with broad associations between words, such as associating "pipe" with "flute" rather than with "smoke," experienced a boost in mood. Take advantage of the positive mood to check whether your solution works. "When you have an insight, it comes with a lot of conviction," Carson says. "So you really have to be objective and evaluate that idea."

This stage is an ideal time to bounce ideas off of trusted friends—their feedback and support could help you determine how well your solution works. Do not be discouraged, though, if your personal eureka is less than perfect. Creative people often describe going through many failures before reaching a successful solution. Those failures help to inform the end result, making them a necessary step in the process. When a student asked chemist and two-time Nobel laureate Linus Pauling how he came up with so many good ideas, he replied, "I have a lot of ideas and throw away the bad ones."

In practice, an individual stage might not always follow easily from the one before it—many people have to revisit earlier steps several times before hitting on inspiration—but ultimately the process can be very rewarding. Creativity does not make only the creators happy; it also benefits all the people who will enjoy their creations.

The joys of an aha! moment may even serve a deeper purpose. In 2013 psychologists Claudia Muth and Claus-Christian Carbon of the University of Bamberg in Germany found that participants who identified a hidden face in a picture liked the image more than those who did not identify the face. Muth hypothesizes that insight is rewarding for evolutionary reasons. She says, "It could explain why we explore the world and why we have interest in things that are new."

How you engage thoughts that arise through new experiences is important for facilitating creativity.

Being curious and pursuing creative endeavors provide you with the opportunity to discover new interests, explore unfamiliar territory, develop expertise and, crucially, take breaks. In short, working to develop and maximize your creativity serves to enrich your life. As Carson puts it, "Once you realize that you can be creative, it opens up this whole new world." ●

Nessa Bryce is a clinical psychology Ph.D. candidate at Harvard University. Her work explores how childhood experiences, particularly traumatic ones, shape our brains and thus how we understand and interact with the world around us.

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Thomas Edison naps under a tree in 1921 while U.S. President Warren Harding (*seated, right*) reads a newspaper.

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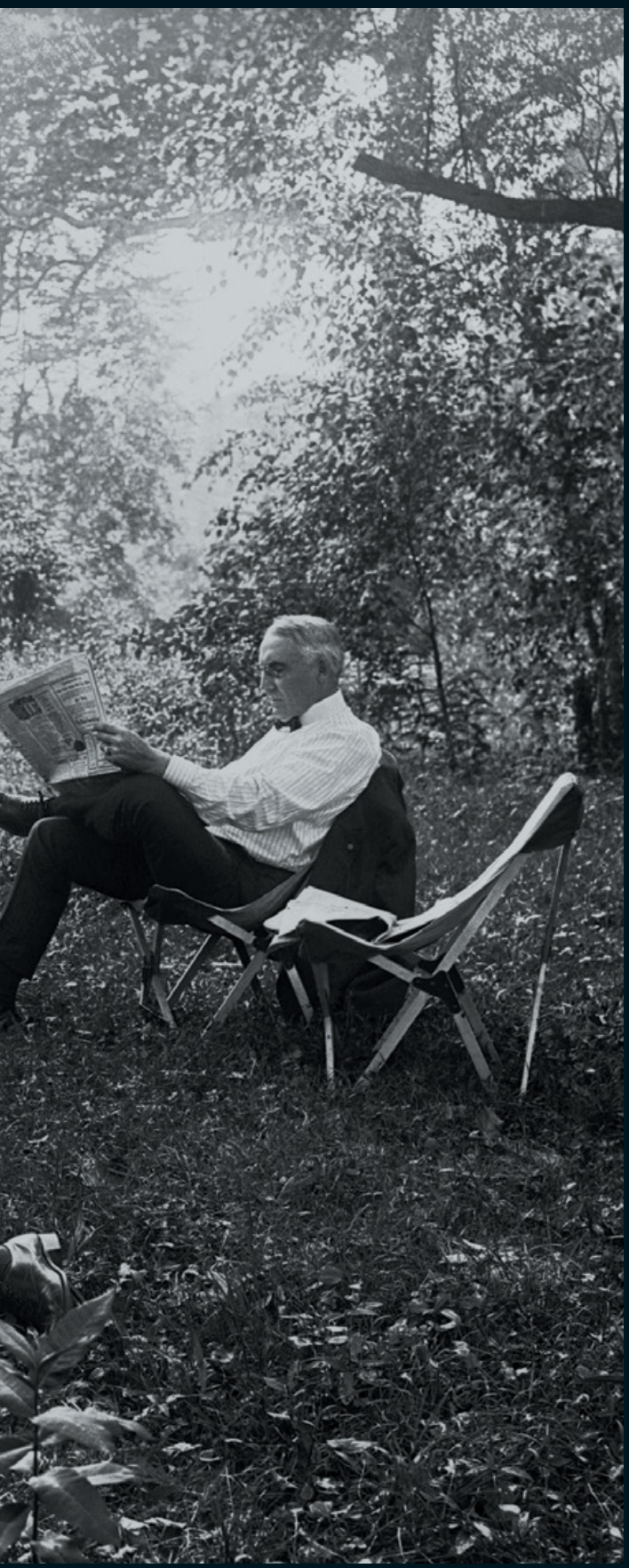

NAP LIKE A GENIUS

Thomas Edison jolted himself from the edge of sleep to boost creativity. His method can work for the rest of us, research indicates

BY BRET STETKA

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THOMAS EDISON WAS famously opposed to sleeping. In an 1889 interview published in *Scientific American,* the ever energetic inventor of the lightbulb claimed he never slept more than four hours a night. Sleep was, he thought, a waste of time.

Yet Edison may have relied on slumber to spur his creativity. The inventor is said to have napped while holding a ball in each hand, presuming that, as he fell asleep, the orbs would fall to the floor and wake him. This way he could remember the sorts of thoughts that come to us as we are nodding off, which we often do not recall.

Sleep researchers now suggest that Edison might have been on to something. A study published in 2022 in *Science Advances* reports that we have a brief period of creativity and insight in the semilucid state that occurs just as we begin to drift into sleep, a sleep phase called N1, or nonrapid-eye-movement sleep stage 1. The findings imply that if we can harness that liminal haze between sleep and wakefulness—known as a hypnagogic state—we might recall our bright ideas more easily.

Inspired by Edison, Delphine Oudiette of Northwestern University and her colleagues presented 103 participants with mathematical problems that had a hidden rule that allowed them to be solved much faster. The 16 people who cracked the clue right away were then excluded from the study. The rest were given a 20-minute break period and asked to relax in a reclined position while holding a drinking glass in their right hand. If it fell, they were then asked to report what they had been thinking prior to letting go.

Throughout the break, subjects underwent polysomnography, a technology that monitors brain, eye and muscle activity to assess a person's state of wakefulness. This helped the researchers determine whether subjects were awake, in N1 or in N2—the next, slightly deeper phase of sleep.

After the break, the study subjects were presented with the math problems again. Those who had dozed into N1 were nearly three times more likely to crack the hidden rule than others who had stayed awake throughout the experiment—and nearly six times more likely to do so than people who had slipped into N2. This "eureka moment," as the authors call it, did not occur immediately. Rather it happened after many subsequent attempts to solve the math problem, which is consistent with previous research on insight and sleep.

It's less clear that Edison's technique of dropping objects to ward off deeper sleep works. Of the 63 subjects who dropped the glass as they drowsed, 26 did so after they had already passed through N1 sleep. Still, the findings suggest that we do have a creative window just before falling asleep.

Oudiette says that, like Edison, her personal experience with sleep inspired the study. "I've always had a lot of hypnagogic experiences, dreamlike experiences that have fascinated me for a long time," she says. "I was quite surprised that almost no scientists have studied this period in the past two decades."

A study published in 2018 found that a brief period of "awake quiescence," or quiet resting, increased the odds of discovering the same mathematical rule used in Oudiette's experiment. And psychologist Penny Lewis of Cardiff University in Wales suggests that rapid-eye-movement (REM) sleep—the phase in which our eyes dart back and forth and most dreams occur—and non-REM sleep work together to encourage problem-solving.

Yet for the most part, Oudiette is not aware of any other research specifically looking at the influence of sleep onset on creativity. She does, however, point to plenty of historical examples of this phenomenon.

Everett Collection, Inc./Alamy Stock Photo (*preceding pages*)

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Resting in his laboratory in New Jersey, Edison took brief breaks from work. But the inventor did not want to spend much time asleep.

Ford Foundation

"Alexander the Great and [Albert] Einstein potentially used Edison's technique, or so the legend goes," Oudiette says. "And some of the dreams that have inspired great discoveries could be hypnagogic experiences rather than night dreams. One famous example is the chemist August Kekulé finding the ring structure of benzene after seeing a snake biting its own tail in a 'half-sleep' period when he was up working late." Surrealist painter Salvador Dalí also used a variation of Edison's method: he held a key over a metal plate as he went to sleep, which clanged to wake him when he dropped it, supposedly inspiring his artistic imagery.

"This study gives us simultaneous insight into consciousness and creativity," says Adam Haar Horowitz of the M.I.T. Media Lab, who has devised technology to interact with hypnagogic states but did not collaborate with Oudiette's team. "Importantly," he adds, "it's the kind of study that you can go ahead and try at home yourself. Grab a metal object, lie down, focus hard on a creative problem, and see what sort of eureka moments you can encounter."

For University of California, Santa Barbara, psychologist Jonathan Schooler, who also was not involved with the project, the study does not necessarily prove that just anyone will be able to mine their creativity during this early phase of somnolence. As he points out, "residing in the 'sweet zone' might have also simply refreshed the study participants, making it easier for them to solve the problem later." But Schooler acknowledges there may be something very solid in the study's findings. "The new results suggest there is a creative sleep sweet spot during which individuals are asleep enough to access otherwise inaccessible elements but not so far gone the material is lost," he says.

Despite its reputation as the brain's period of "shutting off," sleep is, neurologically speaking, an incredibly active process. Brain cells fire by the billions, help to reactivate and store memories, and, it seems, allow us to conjure our mental creations.

Oudiette hopes not only to confirm her findings in future research but also to determine whether focusing on the hypnagogic state can help people address real-world tasks and problems by harnessing the creative potential of that liminal period between sleep and wakefulness. Additionally, she and her colleagues have considered the potential of brain-computer interfaces to precisely identify brain-wave patterns associated with sleep onset, allowing the precise identification of when people should be woken up during their moments of putative insight.

"We could even teach people how to reach this creative state at will," Oudiette envisions. "Imagine playing sounds when people are reaching the right state and other sounds when they are going too far into sleep. Such a method could teach them how to recognize the creative state and how to reach it." ●

Bret Stetka was a writer based in New York City and editorial director of Medscape Neurology (a subsidiary of WebMD). His work has appeared in *Wired,* NPR and the *Atlantic.* He graduated from the University of Virginia School of Medicine in 2005. Stetka died in 2022.

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WHY ANIMALS PLAY

Frolicking hones physical fitness and cognition, allowing creatures to develop skills needed to survive and reproduce

BY CAITLIN O'CONNELL

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IT WAS LATE afternoon in the winter scrub desert within Namibia's Etosha National Park when I spotted a family of elephants on the southern edge of the clearing. I was scanning the horizon from the observation tower where my colleagues and I conduct our research at Mushara water hole. Wind had deterred elephant families from visiting the water hole earlier—it interferes with their efforts to keep tabs on one another vocally—but with the air now still, our first customers of the day had finally appeared.

Judging from how many trunks were stretched high, sampling the air, the group was itching to break cover and run for the water. The young males were particularly anxious to get going. Not only were they thirsty, but they had a lot of sparring to catch up on. As winter wears on, the environment dries out, and elephants have to venture farther from water to find enough to eat. Several days may pass before they can return to the water hole for a drink and a reunion.

I could see why this group was holding back, however. Another elephant family was amassing in the southeastern forest and heading our way, and the adult females were wary. They stood with their feet firmly planted, ears held straight out, as they sniffed what little remained of the prevailing wind for any potential danger. Not only would exiting the security of the forest expose the family to predators, but an encounter with a higher-ranking elephant family could result in an aggressive interaction. For the youngsters in the group, however, more families meant more opportunities to play. So after thoroughly assessing the clearing, the matriarch gave the word with a rumble and an ear flap, and the family began its approach to the water.

Late afternoon is my favorite time of day during our field season in the austral winter—the air cools fast as the sun sinks low in the sky, painting the elephants a radiant pink. My colleagues and I stand in the observation tower with a celebratory drink in hand, our binoculars trained on the horizon, hoping for a sunset visit like this one from one of our beloved resident families. During these daily visits, I always learn a new lesson about elephants—particularly when they play.

I have witnessed the important role of play in calf development and family politics by watching members of my favorite elephant groups frolic at this water hole at sunset. These often chaotic observations inspired me to want to understand more about how animals play and what advantages this behavior might confer, not just to elephants but to all social creatures, including humans. It turns out that play, like other forms of interaction, has rules of engagement. And it is essential for developing the physical and cognitive faculties that animals need to survive and reproduce.

RULES AND REGULATIONS

PEOPLE TEND TO THINK of play as an activity one engages in at one's leisure, outside of learning important skills needed to succeed later in life, such as hunting, mating, and evading predators. But although playing is fun for all involved—and fun for those who are watching—play behaviors evolved as ritualized forms of survival skills needed later in life, providing the opportunity to perfect those skills.

Engaging in play allows animals to experiment with new behaviors in a protected environment without dangerous consequences. The unwritten code of con-

Joachim Schmeisser (*preceding pages*)

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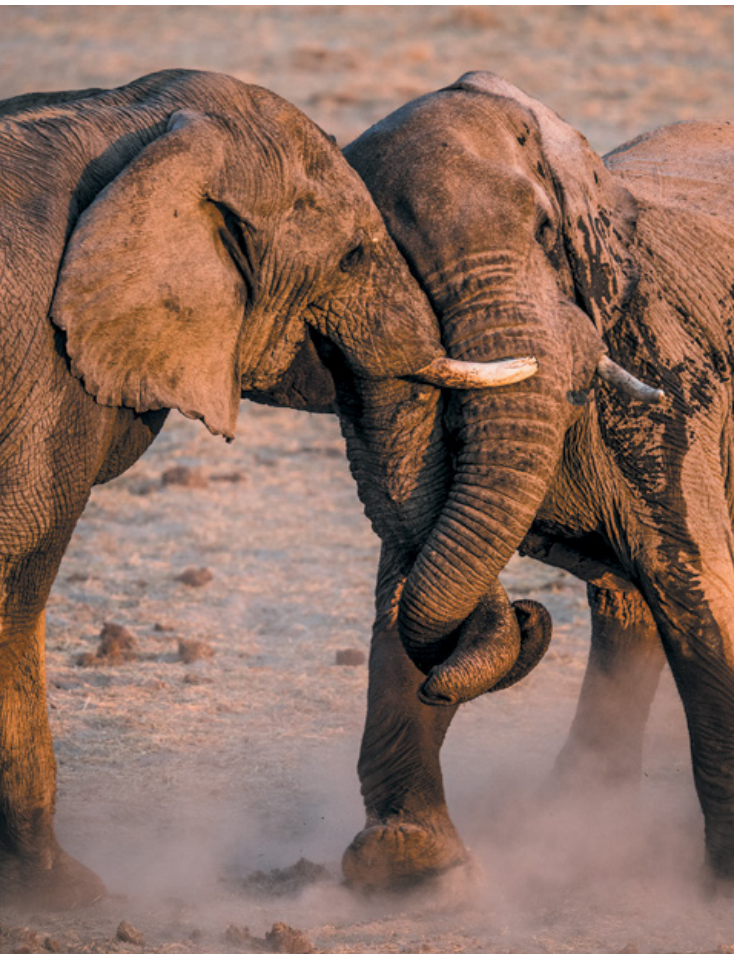

duct surrounding play lets them explore many possible outcomes.

Animals learn the rules of engagement for play at a very young age. Among dogs, the bow is a universal invitation to engage in silliness that triggers the same bowing down and splaying of the front legs in the receiver of the signal—inevitably followed by chasing and pretend biting. Chimpanzees and gorillas motivate others to romp by showing their upper and lower teeth in what primatologists refer to as a play face, which is comparable to human laughter.

When a young male elephant wants to play with another male of similar age, he holds his trunk up and presents it to the other as an invitation. Most often his next move would be to place his trunk over the other's head, which in adults signals dominance but in calves is guaranteed to precipitate a spirited sparring match. These encounters run the gamut from gentle shoving to intense headbutting and pushing back and forth with trunks entwining and tusks clacking. The fun continues for seconds to minutes for youngsters; for older teens and young adults, it can go on much longer. The sparring matches provide bulls with the opportunity to test their fighting ability so that they might successfully compete for a female when they reach sexual maturity and enter the hormonal state of musth around the age of 25.

When a young male elephant is feeling particularly adventurous, he may venture far away from Mom's protection to invite a distant relative to spar. If his foray takes him too far away or if a spar turns unexpectedly rough, the brave calf will lose his nerve and often will run quickly back to Mom's side with ears flapping and trunk yo-yoing as he retreats.

Occasionally an older sister will oversee a play bout between youngsters. These ever watchful siblings form part of an extended caretaking network that facilitates play, but its members also will intervene if a calf crosses an invisible bloodline and gets deflected with a trunk slap by an overly protective, high-ranking mother.

FORMS OF PLAY

SCHOLARS OF ANIMAL BEHAVIOR recognize three main categories of play. The first is social play, which is any kind of antic that involves others. The second is locomotive play—including running, walking, jumping and pouncing—which facilitates lifelong motor skills. In prey species, locomotive play helps to perfect predator-avoidance tactics such as the springbok's "pronking" high into the air while running as a herd and landing in unpredictable spots. In elephants, it hones predator-avoidance skills, as well as strategies for escaping an aggressive suitor or a competitor looking to inflict a mortal wound. Conversely, young predators such as lion cubs use locomotive play to sharpen their hunting ability. Chasing and tripping littermates and then giving them a good chew on the spine or throat are rehearsals

Play sharpens survival skills: Elephant calves extend an invitation to play by placing their trunk over another's head (*bottom right*). Sparring is an important play behavior that helps build strength and test new defense maneuvers in a safe zone (*left*). An older elephant may kneel down to provide an opportunity for a young male relative to spar (*top right*).

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of the skills needed to catch prey animals and dispatch them by severing their spinal cord or choking them.

Many species, including our own, engage in the mock-fighting variety of locomotive play, which allows them to test their strength in a safe environment where everyone understands the rules. A playful spar in elephants is just like an arm wrestle between human peers. When play becomes more elaborate and determined, it turns from an arm wrestle into something akin to martial arts, allowing both participants to practice skills and develop innovative solutions that could help them avoid mortal combat later in life. Play fighting also provides opportunities to test boundaries, gauge who can be trusted and learn important body language.

The third main category of play is object play, which incorporates objects from the environment into the cavorting. For an elephant, this object might take the form of a stick or branch that the elephant explores, carries or throws with its trunk. In captivity, elephants enjoy playing with balls or hauling inner tubes around for fun. Alternatively, the object could be another animal, such as a zebra or giraffe, that offers an irresistible opportunity for a chase. In one case, a four-year-old male calf named Leo taught his baby brother, Liam, just how fun such a chase can be, leaving Liam scrambling to keep up with Leo's charge as a giraffe made a quick escape.

Two other forms of play have been documented only in great apes, including humans. One of these, game playing, combines social, locomotive and object play. Sports such as soccer, field hockey, lacrosse and polo are examples of traditional games that became formalized as sports with specific sets of rules (among nonhuman great apes, only captive individuals raised in human contexts play formal games). The other variety of play that appears to be unique to great apes is make-believe. For example, a wild chimpanzee may carry around a small log, pretending it is an infant. A human child might play with an invisible toy or set up an invisible barrier that they want adults to acknowledge.

NOT JUST FUN AND GAMES

PLAY PROVIDES AN ENVIRONMENT for experimenting with risk. When a lion cub deliberately gives up some control over its body, it puts itself at a disadvantage, allowing others to succeed in pouncing on it. Marc Bekoff of the University of Colorado Boulder and his colleagues have proposed that play increases the versatility of movements used to recover from a loss of balance and enhances the ability of the player to cope with unexpected stressful situations. The goal is not to win but to improve skills, sometimes by self-handicapping.

Once a cub has been tackled by its littermates, roles might reverse such that a littermate handicaps itself, allowing the other cub to tackle it in return. Self-handicapping is risky and requires trust, but it is a great way to develop strength and agility. It is also an important exercise in building cooperation. In the Sawtooth wolf

Play provides an environment for experimenting with risk.

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Animals learn the rules of engagement for play early on. Among dogs, the "bow" is a universally understood invitation to play (*left*). Young predators such as lion cubs use play to develop their hunting skills (*right*).

Nicola Gavin/Alamy Stock Photo (*left*); Manoj Shah/Getty Images (*right*)

pack raised by Jim and Jamie Dutcher in the Sawtooth Mountains in Idaho, the dominant wolf would slow down to allow a close companion that happened to be a subordinate to catch up and tackle him. In elephants, on a number of occasions I have seen older male calves crouch down to allow a much younger calf to spar with them. This is akin to an older brother handicapping himself during an arm wrestle by not using all of his strength to let his little brother win.

Being silly is another important aspect of play, one that gets us outside our comfort zone and forces us to test new strategies. Silliness in our movements, behavior and even language helps us think much more broadly and creatively. Problem-solving derived from the silliness of play has been demonstrated in many species and even in robots. When mechanical engineer Hod Lipson of Columbia University gave his artificial-intelligence robots a chance to play—by dancing around in random movements—they outperformed other robots when challenged with the unexpected. The positioning information garnered from moving around randomly led one robot to come up with creative solutions for maintaining its balance after losing a limb.

Likewise, when sea lions play in the surf, they often project themselves high into the air midway down the face of monster waves, like those that roll into Santa Cruz. These are just the kinds of behaviors needed to avoid an attack by a great white shark—their primary predator apart from killer whales and humans.

Play also builds trust. Thomas Bugnyar of the University of Vienna in Austria and his colleagues found that ravens pretend to cache highly valued food items and then watch how other ravens respond, apparently to determine whom they can trust. Learning how to differentiate competitors from likely reliable collaborators early on has obvious advantages, whether one wants to gain allies or build a coalition within a group—or repair broken relationships.

FAMILIES REUNITED

"INCOMING FROM THE SOUTHEAST!" I called out from the Mushara tower as my elephant field team narrowed in on what looked like a dusty line of pinkish-gray boulders amassing on the edge of the clearing one afternoon during our 2018 field season. The search for identifying features began. A missing tusk, a notch in the bottom of the left ear, or a V-shaped cut in the top of the right ear would give the family away. Whoever identified the elephant family first would get an extra sundown drink.

That day the incoming family turned out to be the Actors. It was our first sighting of the group that season, and we were excited to see a new addition to the family: high-ranking Susan, identified by her daggerlike left tusk, had a new male calf, Liam. And low-ranking Wynona, who was missing her left tusk, had her two-year-old calf Lucy in tow. We had been following the contentious dynamic between these two mothers very closely over the years, particularly during the 2012 season when each had a calf—Leo and Liza, respectively.

Susan had relentlessly tormented Wynona all the

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way up to the end of her pregnancy, aggressively charging her whenever she got close to the water to drink. The tension was so high that when Wynona broke away from the family to give birth, surrounded by her daughter Erin and their calves, I worried for her baby's life if a reunion were to take place. Sure enough, there was no fanfare and no reunion that we witnessed to present her new baby to the rest of the family. I assumed then that Wynona's days as a member of the Actor family were numbered.

As predicted, Wynona did separate from the larger family and became the matriarch of her own core family. It went on like that for four years until the arrival of Wynona's newest baby, Lucy, in 2016 yet again changed the dynamic of the larger extended family group. Play appeared to be an important contributing factor in reuniting the family.

Lucy's older sister, Liza, had been a shy baby who stuck to her mom and her very close relatives. Wynona timed her movements to avoid too much overlap with the larger family group when they went to Mushara water hole to drink. They tended to be one day behind or ahead of the Actor family, usually behind. On the rare occasion that they did overlap just at the end of the extended family visit, Liza did not stray to interact with the larger family. And who would blame her? Susan was right there with a quick jab with her dagger tusk or a trunk slap, whichever was more convenient, making it clear that the low-ranking babies had no place on the playground with royalty. There was hardly a chance for calves of Wynona's small but growing family to get to know members of the extended family.

Lucy changed all that. From the start, she was quite the extrovert. Maybe being born into a very small family made her all the more curious and excited by the opportunity to engage with the extended family on the infrequent occasion of their overlapping. And she was not deterred by the admonishments of high-ranking moms within the extended family, much to the seeming annoyance of the ever watchful Susan.

Now the two-year-old Lucy knew just how to run through adults' legs and out of trunk's reach, navigating potential minefields and dodging her mom's attempts to rein her in. She behaved more like Susan's calf, Leo, who was her older sister Liza's contemporary. When we scored Leo's distance from his mom at the water hole, he always had a much higher score than Liza. We had assumed that was attributable mainly to his sex and the male elephant's early experiments with independence. But the arrival of Lucy showed us that the story was not that simple.

Among wild elephants, play is almost always a group affair. For youngsters, it often includes piling on top of siblings, cousins or, if permitted, even older family members.

Lucy spent a lot of time a great distance away from her mom and played with calves of mothers of all ranks. When it came time to leave the water hole and go in separate directions, as dictated by the prevailing family politics, Lucy made that impossible. She was so busy playing with other calves that there was no extracting her, leaving Wynona no choice but to modify her behavior.

Instead of continuing on her premeditated departure route, in the opposite direction from the Actor family, Wynona, her eldest daughter Erin and their calves turned around and followed the rest of the family so that Wynona did not risk losing her new calf. There was no guarantee that the other mothers would protect Lucy, much less allow her to suckle, as that would mean fewer precious nutrients for their own calves. But by 2018 Wynona was fully reintegrated into the Actor family, whether she wanted to be or not.

Every time I see this dynamic unfold, it makes me smile. How often is it the case in our own families that grudges of older generations are put aside because of the bonds forged by the next generation through play?

Play should be on our daily agenda. Smiling and laughing are contagious behaviors that facilitate bonding, are curative and, most important, do not have to take up much time. The next time you feel like you are too busy to play a frivolous game at work or you don't want to face that family reunion, make the time and muster the will. You might be surprised at the outcome, whether it be a better idea for a pitch meeting or the dissolution of a long-standing barrier between you and a contentious relative thanks to a good giggle.

Our highly adaptable and innovative nature is rooted in play. I am grateful to my favorite elephant, Wynona, and her daughter Lucy for reminding me that there is always something new we can learn from it—and that we are never too old to internalize those lessons. A good romp can pay off in ways I hadn't anticipated. It forges new bonds, reunites divided families, improves coping skills and overall health, and facilitates cooperation and innovation. Given all these benefits, how could we afford not to play? ●

How often in our own families do grudges of older generations get put aside because of bonds forged by the next generation through play?

Caitlin O'Connell is a behavioral ecologist at Harvard Medical School. Her research focuses on elephant behavior and communication. O'Connell's latest book is *Wild Rituals: 10 Lessons Animals Can Teach Us about Connection, Community, and Ourselves* (Chronicle Prism, 2021).

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SURVIVAL OF THE FRIENDLIEST

Natural selection for hypersocial traits enabled Earth's apex species to best Neandertals and other competitors

BY BRIAN HARE AND VANESSA WOODS
ILLUSTRATIONS BY MATT HARRISON CLOUGH

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WE ARE THE only humans now, but not so long ago we had company. In the roughly 300,000 years of our existence, *Homo sapiens* has shared the planet with at least four other human species. In hindsight, it seems obvious why we prevailed. We were the best hunters, the smartest, the most technologically savvy.

But that is only the story we tell ourselves. Some of the other human species were more technologically advanced, had been around for much longer—a million years—or had brains as big as or bigger than ours. Going back 100,000 years, if you were to guess which human species was going to make it, one of the other humans, perhaps Neandertals, would have been a good bet.

We shared a common ancestor with Neandertals. They were stronger than us, barrel-chested with muscle. They were highly skilled with weapons and hunted every large mammal in the Ice Age. They even shared with us a variant of a gene known as *FOXP2,* thought to be required for the finely calibrated movements needed for speech. Their culture demonstrated high levels of sophistication: Neandertals buried their dead, cared for the sick and injured, painted themselves with pigment, and adorned themselves with jewelry made of shells, feathers and bone.

The first *H. sapiens* to arrive in Europe met a relatively large population of Neandertals who were well adapted to a cold-weather climate. Later, as glaciers advanced, modern humans fled, and Neandertals stayed and thrived. Compared with our closest living relatives, bonobos and chimpanzees, our species has little genetic variation, which suggests that at some time, perhaps several times, we experienced a severe population bottleneck, which means we might almost have gone extinct. If we were not the strongest or the smartest, how did we win?

HUMAN SELF-DOMESTICATORS

COMPARED WITH OTHER human species, it turns out we were the friendliest. What allowed us to thrive was a kind of cognitive superpower: a particular type of affability called cooperative communication. We are experts at working together with other people, even strangers. We can communicate with someone we have never met about a shared goal and work together to accomplish it. We develop this superpower before we can walk or talk, and it is the gateway to a sophisticated social and cultural world. It allows us to plug our minds into the minds of others and inherit the knowledge of generations. It is the foundation for all forms of culture and learning, including sophisticated language.

This friendliness evolved through a process known as self-domestication. Domestication is a process that involves intense selection for friendliness. When an animal is domesticated, in addition to becoming much friendlier, it undergoes many changes that appear completely unrelated to one another. This domestication syndrome shows up in the shape of the face, the size of the teeth, and the pigmentation of different body parts or hair; it includes changes to hormones, reproductive cycles and the nervous system. Although we think of domestication as something that we do to animals, it can also occur through natural selection in what we call self-domestication.

The self-domestication hypothesis was developed over the past 20 or so years from our work with anthropologist Richard Wrangham of Harvard University and psychologist Michael Tomasello of Duke University. What we discovered is that self-domestication also increases the key to our success: the ability to cooperatively communicate with others. The hypothesis predicts that if *H. sapiens* were self-domesticated, we should find evidence of selection for friendliness in the Pleistocene (2.6 million to 11,700 years ago). Although behavior does not fossilize, the neurohormones that regulate behavior shape our skeletons, and we can trace these changes through paleoanthropological specimens.

For example, the more testosterone you have available during puberty, the thicker your brow ridge and the longer your face becomes. Men tend to have thicker, more overhanging brow ridges and slightly longer faces than women, so we call a face with these traits masculinized. Testosterone does not directly cause human aggression, but its levels and its interactions with other hormones do modulate aggressive behavior.

Anthropologists frequently remark on the decreas-

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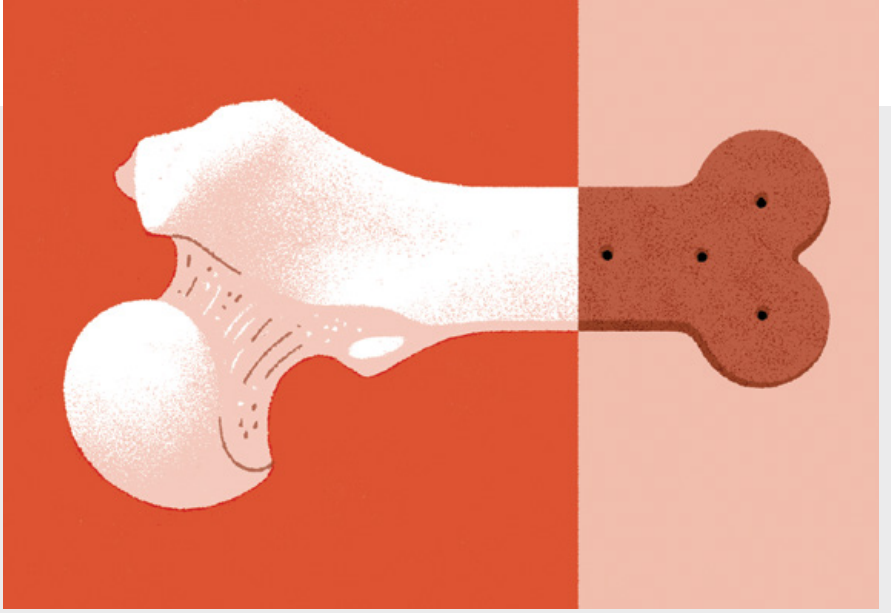
From Wolf to Dog

An amicable disposition also governed the course of evolution for an animal that turned into a favorite pet



Humans are not the only ones who underwent self-domestication. So did our close relatives the bonobos—and the species we call our best friend. A tiny fraction of the genome differentiates dogs from wolves, yet millions of dogs are snugly curled up in our homes while wolves slink around at the edge of extinction. True, dogs run into doors and drink out of our toilets, but they also protect our loved ones, fight in our wars, detect drugs and cancer, calm autistic children, and give many of us unconditional love and a reason to go outside and exercise.

When our research group began its work about two decades ago, we discovered that dogs also have extraordinary intelligence: they can read our gestures better than any other species, even bonobos and chimpanzees. Wolves, in contrast, are mysterious and unpredictable. Their home is the wilderness, and that wilderness is shrinking.

But not so long ago the evolutionary race between dogs and wolves was so close, it was unclear who would win. Dogs, in fact, did not descend from wolves. Instead dogs and wolves shared a wolflike ancestor, whom we will call the Ice Age wolf to distinguish it from today's animals. Ice Age wolves were highly successful: they survived after every large carnivore—saber-toothed cats, cave lions and giant hyenas—had gone extinct. They spread throughout most of the Northern Hemisphere and became one of the most successful predator species in the world.

Folklore supposes that humans brought wolf puppies into camp and domesticated them. Or as wolf expert David Mech wrote in 1974, "Evidently early humans tamed wolves and domesticated them, eventually selectively breeding them and finally developing the domestic dog (*Canis familiaris*) from them."

But this story has not held up. An animal is tamed during its lifetime. Domestication happens over generations and involves changes to the genome. That is only one difference between domesticating and taming an animal. Even today wolves eat too much meat—as much as 20 pounds in a single feeding—to be a sustainable hunting partner. Ice Age wolves were much larger than modern wolves. At the time of dog domestication, humans were hunter-gatherers, going out to forage and leaving their children in camp—no sensible human would have let them be unprotected against a carnivore of that size.

Dogs have shorter snouts and reduced versions of the long canine teeth compared with wolves. Their hair changes color to cover them in random splotches. Their tails curl, sometimes in a full circle—and they have floppy ears. Instead of having one breeding season, they can breed throughout the year.

Taken together, these traits are part of the domestication syndrome, and an assortment of them appear in a domesticated species. But no one knew what tied these traits together, or if they were related at all, until a Russian geneticist decided to domesticate foxes in a remote outpost in Siberia.

In 1959 Dmitry Belyaev began breeding them using a single selection criterion: whether the fox would approach a human hand. After 50 generations, these friendly foxes would leap into your arms, lick your face and pee for joy.

When our research group tested the foxes, we found that, like dogs, they were better at reading intentions from our gestures. The foxes were bred only to be unafraid and attracted to humans. But other changes, including an increase in social intelligence, happened by accident.

So how did wolves turn into dogs? Back in the Ice Age, as our human populations grew more sedentary, we probably created more trash, which we then dumped outside our camps. These leavings would have included tempting morsels for hungry wolves. Only the friendliest wolves would have been able to scavenge, however. These animals would have had to be unafraid of humans, and if they displayed any aggression toward us, they would have been killed.

These friendly wolves would have been at a reproductive advantage and, because they scavenged together, more likely to breed together. After generations of selection for friendliness without intentional selection by humans, this special population of wolves would have begun to take on a different appearance. Coat color, ears, tails—all probably started to change. We would have become increasingly tolerant of these odd-looking scavenger wolves and would quickly have discovered that they had a unique capacity for reading our gestures.

Animals that could respond to our gestures and voices would be very useful as hunting partners and guards. They would have been valuable as well for their warmth and companionship, and slowly we would have allowed them to move from outside our camps to our firesides. We did not domesticate dogs. The friendliest wolves domesticated themselves.

In the 14,000 to 40,000 years during which this domestication process occurred, wild wolves were probably doing better than dogs in terms of numbers—after all, our dogs were probably another food source for humans when times became lean. The first written record of a wolf hunt was recorded in the sixth century B.C.E., when Solon of Athens offered a bounty for every wolf killed.

This event was the start of a systematic massacre that almost eradicated wolves permanently. In 2018 their population was estimated as fewer than 300,000 worldwide. The global dog population is currently close to a billion. The history of dogs and wolves demonstrates how friendliness as a trait translates into a winning evolutionary strategy. —*B.H.* and *V.W.*

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ing brow ridges, shortening faces and shrinking heads of humans throughout the Paleolithic. In our research, we realized that if we documented those changes, they would point to when physiological changes occurred that shaped our behavior and bodies at the same time.

Together with researchers Steven Churchill and Robert Cieri, then both at Duke, we found that *H. sapiens* prior to the 80,000-year mark, the Middle Pleistocene, had longer faces and much larger brow ridges than in the Late Pleistocene. On average, skulls more recent than 80,000 years ago had a 40 percent reduction in how far their brow ridges projected from the face. They were also 10 percent shorter and 5 percent narrower than the older skulls before that dividing point. Although the pattern varied, it continued so that the faces of modern hunter-gatherers and agriculturalists grew more delicate in appearance, indicating a decrease in testosterone. Another neurohormone, serotonin, may have promoted a set of changes that led to smaller brains and less aggression. Increases in serotonin appear early on during the domestication syndrome—and the chemical may also be involved in skull development.

Self-domestication is a scientific hypothesis that suggests *Homo sapiens* underwent selection for friendliness—as evidenced by both our behaviors and physical traits.

Drugs that increase serotonin availability in the brain, such as selective serotonin reuptake inhibitors (SSRIs), make people more cooperative and less willing to harm others when tested during social science experiments examining moral dilemmas and cooperation. Serotonin does not just change behavior. If exposure occurs early in development, it also appears to alter skull morphology. Pregnant mice given SSRIs have babies with shorter, narrower snouts and skulls described as globular.

Every other human species had a low, flat forehead and a thick skull. Neandertals had heads shaped like footballs. Only we have the balloonlike skulls that anthropologists call globular. This shape indicates a possible increase in the availability of serotonin during our evolutionary development. Based on the fossil record, these changes started after we split from our common ancestor with Neandertals—and they have continued in the relatively recent evolutionary past. In fact, the work of one of us (Hare) with Churchill and Cieri suggests that our skulls—and hence brain size—have been shrinking over the past 20,000 years.

If testosterone and serotonin levels changed in *H. sapiens* as a result of domestication, another molecule probably did as well. Lower testosterone and higher serotonin enhance the effects of the hormone oxytocin on social bonding. Oxytocin floods through mothers during childbirth. It facilitates milk production and is passed on through breast milk. Eye contact between parents and babies creates an oxytocin interactive loop, making both parent and baby feel loving and loved. When psychologist Carsten de Dreu of Leiden University in the Netherlands and other researchers gave people oxytocin to inhale in an experiment, the subjects tended to be more cooperative, empathetic, and trusting in financial and social games.

All these changes had lasting impacts on our social relationships. In fact, we think these changes produced a new social category: the intragroup stranger. Our evolutionary cousins bonobos and chimpanzees recognize strangers based only on familiarity. Someone who lives with them inside their territory is a group member. Everyone else is a stranger. Recognition is clear-cut. An individual is either familiar or an outsider.

Chimpanzees may hear or see their neighbors, but the interaction is almost always brief and hostile; in contrast, bonobos are friendlier with outsiders. We, too, respond to individuals who are unfamiliar in different ways, but unlike any other animal, we also have the ability to instantly recognize whether a stranger belongs to our group. Humans can define our groups based on appearance, language or a set of beliefs. Our ever changing conception of group status allows us to recognize those like us—even if we have never met them. It also lets us expand our social network far beyond the size of any other human species.

Every day, without thinking about it, we adorn ourselves in ways that make us identifiable to one another—donning sports jerseys, political pins or religious symbols on a necklace. This capacity dominates our modern lives. It encourages us to perform acts of kindness both great and small—donating an organ to a stranger or helping someone cross the street. It also helps us share and improve our best ideas.

THE LIGHTS STAY ON

EVEN THOUGH OUR Neandertal cousins seemed to have an edge on us early on, around 80,000 years ago, signs that *H. sapiens* might not just prevail but flourish began to appear.

Glimpses of social sophistication and advanced technology can be found in archaeological remains from when we first emerged as a species in Africa as long as 300,000 years ago. But these sites were like lights blinking on and off. Technology and other signs of progress appeared, then disappeared. Starting about 80,000 years ago, these lights seemed to stay on and grow stronger. We think the new category of intragroup stranger appeared in our species around then, when the fossil record suggests complex cultural traditions and technologies began to spread across long distances. Expanded social networks meant

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more cultural innovations could be shared at greater speed. Cultural and technological progress exploded.

From 50,000 years onward humans began to leave evidence of our expanding social networks and cultural prowess wherever we lived around the world. Jewelry made from shells has been found hundreds of miles inland, implying that an object with no practical value either was worth carrying some distance or was obtained from someone else who had traveled on one of our first trade routes. We painted animals on rocks so skillfully that the contours of the stone rippled beneath their bodies and seemingly gave them a third dimension.

The idea that friendliness led to our success is not new. Neither is the idea that as a species, we became more intelligent. Our discovery lies in the relationship between the two ideas: it was an increase in social tolerance that led to cognitive changes, especially those related to cooperative communication.

The arrival of human self-domestication would have led to both the increase in population and the revolution in technology we see in the fossil record. Friendliness drove these changes by linking groups of innovators together in a way other human species never could. Self-domestication gave us a superpower, and in the blink of an evolutionary eye, we took over the world. One by one, every other human species went extinct.

This optimistic view of our species is immediately at odds with the misery and suffering we still inflict on one another. If human self-domestication explains the best in us, does it also explain the worst? How do we reconcile our kindness with our cruelty?

Some of the same neurohormonal changes underlying friendliness also support horrific violence. Oxytocin seems crucial to parental behavior and has been called the hug hormone. But a better name would be the mama bear hormone. The same oxytocin that floods through a mother with the arrival of her newborn feeds the rage she feels when someone threatens that baby. For example, hamster mothers given extra oxytocin are more likely to attack and bite a threatening male. Oxytocin is also implicated in related forms of male aggression. Available oxytocin increases when a male rat bonds with his mate. He is more caring toward her but also more likely to attack a stranger threatening her. This link connecting social bonding, oxytocin and aggression is seen widely among mammals.

As our species was shaped by self-domestication, our increased friendliness also brought a new form of aggression. A higher availability of serotonin during human brain growth increased the impact of oxytocin on our behavior. Group members had the ability to connect with one another, and the bonds among them were so strong, they felt like family. New concern for others came with a willingness to violently defend unrelated group members. Humans became more violent when those we evolved to love more intensely were threatened.

LOVE IS A CONTACT SPORT

DESPITE THE EVOLUTIONARY paradoxes of human nature, the perception of who belongs in our group is malleable. *H. sapiens* as a species has already demonstrated its capacity to expand the concept of group membership into the thousands and millions.

It can be extended further. The best way to diffuse conflict among groups is to diminish the perceived sense of threat through social interaction. If feeling threatened makes us want to protect others in our group, nonthreatening contact between groups allows us to expand the definition of who our group is.

White children who went to school with Black children in the 1960s were more likely, as they grew up, to support interracial marriage, have Black friends, and be willing to welcome Black people into their neighborhoods.

That formula still works in education. Pairs of roommates at the University of California, Los Angeles, who each were from a different race reported more comfort in mixed-race interactions and approval of mixed-race dating. One study found that imagining positive contact with one of the most dehumanized groups of people—the homeless—helps others to empathize with them. The friendships of individuals from different groups can also generalize beyond their friendship to other group members.

Most policies are enacted with the assumption that a change in attitude will lead to a change in behavior, but in the case of intergroup conflict, it is the altered behavior—in the form of human contact—that is more likely to change minds. The self-domestication hypothesis explains why we as a species evolved to relate to others. Making contact with people of a different ideology, culture or race is a universally effective reminder that we all belong to a single group called *H. sapiens*.

This gave us the edge we needed to outlast other members in the hominin line. In evolutionary terms, the definition of friendliness relates to positive behaviors, either intentional or unintentional, toward others. It involves not only close physical proximity while group size expanded but also an ability to rapidly read people's intentions. The benefits of social interactions for our species' success—the ability to solve problems better than individuals can on their own—proved so significant that they influenced the way selection shaped our bodies and minds. The resulting ability to share knowledge across generations produced the technology and culture that allowed us to populate every corner of the planet. ●

Brian Hare is a professor of evolutionary anthropology, psychology and neuroscience at Duke University.

Vanessa Woods is a research scientist and director of the Duke Puppy Kindergarten. Woods and Hare's latest book, *Survival of the Friendliest,* was published in 2021 by Random House.

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OPINION

KINDNESS GOES FARTHER THAN YOU THINK

Small acts boost recipients' moods in big ways BY AMIT KUMAR

SCIENTISTS WHO STUDY happiness know that being kind to others can improve well-being. Acts as simple as buying a cup of coffee for someone can boost a person's mood, for example. Everyday life affords many opportunities for such actions, yet people do not always take advantage of them.

In studies published online in the *Journal of Experimental Psychology: General,* Nicholas Epley, a behavioral scientist at the University of Chicago Booth School of Business, and I examined a possible explanation: people who perform random acts of kindness underestimate how much recipients value their behavior.

Across multiple experiments involving approximately 1,000 participants, people performed a random act of kindness—that is, an action done with the primary intention of making someone else (who isn't expecting the gesture) feel good. Those who perform such actions expect nothing in return.

From one situation to the next, the specific acts of kindness varied. For instance, in one experiment, people wrote notes to friends and family "just because." In another, they gave cupcakes away. Across these experiments, we asked both the person performing a kind act and the one receiving it to fill out questionnaires.

We asked the person who had acted with kindness to report their own experience and to predict their recipient's response. Because we wanted to understand how valuable people perceived these acts to be, we asked both the performer and the recipient to rate how "big" the act seemed. In some cases, we also inquired about the actual or perceived cost in time, money or effort. In all cases, we compared a given performer's expectations of the recipient's mood with the recipient's *actual* experience.

Across our investigations, several robust patterns emerged. For one, both performers and recipients of the acts of kindness were in more positive moods than normal after these exchanges. For another, it was clear that performers undervalued their impact: recipients felt significantly better than the kind actors expected. The recipients also reliably rated these acts as "bigger" than the people performing them did.

We initially studied acts of kindness done for familiar people, such as friends, classmates or family. But we found that participants underestimated their positive

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impact on strangers as well. In one experiment, participants at an ice-skating rink in a public park gave away hot chocolate on a cold winter's day. Again, the experience was more positive than the givers anticipated for the recipients, who were people who just happened to be nearby. Although the people giving out the hot chocolate saw the act as relatively inconsequential, it really mattered to the recipients.

Our research also revealed one reason that people may underestimate their action's impact. When we asked one set of participants to estimate how much someone would like getting a cupcake simply for participating in a study, for example, their predictions were well calibrated with recipients' reactions. But when people received cupcakes through a random act of kindness, the cupcake givers underestimated how positive their recipients would feel. Recipients of these unexpected actions tend to focus more on *warmth* than performers do.

Missing the importance of warmth may stand in the way of being kinder in daily life. People know that cupcakes can make folks feel good, to be sure, but it turns out that cupcakes given in kindness can make them feel *surprisingly* good. If people undervalue this effect, they might not bother to carry out these warm, prosocial behaviors.

And kindness can be contagious. In another experiment, we had people play an economic game that allowed us to examine what are sometimes called "pay it forward" effects. In this game, participants allocated money between themselves and a person whom they would never meet. People who had just been on the receiving end of a kind act gave substantially more to an anonymous person than those who had not. The person who performed the initial act did not recognize that their generosity would spill over in these downstream interactions.

These findings suggest that what might seem small when we are deciding whether to do something nice for someone else could matter a great deal to the person we do it for. Given that these warm gestures can enhance our own mood and brighten the day of another person, why not choose kindness when we can? ●

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Illustration by Chanelle Nibbelink

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An early open-plan office, designed by architect Frank Lloyd Wright for the S. C. Johnson company in the 1930s, was intended to boost productivity.

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WHY PEOPLE HATE OPEN OFFICES

Open-plan offices create health and productivity problems. Now insights from Deaf and autistic design communities could improve them BY GEORGE MUSSER

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IN 1967 chemical company DuPont gutted a floor of an office building in Delaware and rebuilt it. The firm put almost everyone into one big room with low partitions. In one corner, they provided a lounge with armchairs and Eero Saarinen end tables. This was the first major corporate adaptation of an "open plan" office in the U.S., following the latest thinking by German architectural designers. Those designers held that companies increasingly relied on professionals—or knowledge workers, a term coined in 1959—who bristled at corporate hierarchies and needed more opportunities to collaborate. At DuPont, the new arrangement housed the company's Freon refrigerant division. Freon began to be phased out in 1987 because it was destroying Earth's ozone layer. The open-plan office, in contrast, has spread far and wide. By 2020 two thirds of knowledge workers in the U.S. worked in one, according to a survey by global architecture and design firm Gensler.

Most people wish they didn't. The writing has been on the cubicle partition since the very first survey comparing this with other office designs was published in 1970. "Few … like a completely open plan with little privacy," the author wrote. The respondents—358 employees at 18 companies—complained about noise, distraction and soullessness. Apart from some references to ashtrays, the survey might as well have been written in 2020. In a sense it has been: dozens of recent surveys have recapitulated these findings. It's now well established that open-plan offices fail to accomplish one of their major stated goals—increasing collaboration. Instead, researchers have found, they drive workers into more isolation. The design may also heighten office sexism and health troubles.

For convincing corporate real estate managers that open plans are bad ideas, no survey has had as much impact as an impromptu worldwide experiment, conducted during the past three or four years, called the COVID pandemic. It proved that most people who used to work in an office can work equally well from home. They're Slacking, not slacking off. The pandemic also reminded everyone that open offices are germ-filled petri dishes. (This was known before: in 1995 a Finnish study found that sharing an office increased the chance of catching multiple colds a year by a third, nearly the same level of elevated risk as being a parent of young children, who repeatedly bring colds home from schools and day care.)

Gensler, in another survey in 2021, found that nearly a third of people asked said they wanted to work from home indefinitely. Half preferred a hybrid arrangement—ideally two office days a week. These new working habits have upended corporate office strategy. Companies that kept shaving inches off workstations to cram in more people now have half-empty facilities. "The office thing is all buggered up," says Alison Hirst, a business professor at Anglia Ruskin University in England, who has done case studies of the social dynamics in open offices.

Now designers are rethinking not so much the idea of an open office as its execution. In particular, they are doing more to accommodate a diversity of working styles. This trend overlaps with a movement toward inclusive design, which seeks to support people who are hard of hearing or autistic, as well as others who have trouble with conventional offices. Some of the architectural changes that reduce discomfort and productivity issues for these people work for open-plan offices in general. Companies, still looking at their real estate bills, don't seem inclined to give employees back their private spaces, but they may change how workspaces function.

For example, Gavin Bollard, an information technology manager in Australia, who blogs about his experiences with autism, is deaf and uses hearing aids. "I've always struggled with the sound design of the open-plan office structure because it's hard to know how loud I am talking, and it's hard to hear effectively when others are trying to be quiet," he says. Both autistic and deaf people also object to visual clutter, harsh lighting and a feeling of personal vulnerability in an open plan.

These are universal complaints. "Autistic people are canaries in the coal mine: our needs aren't actually different from typical people's, just more intense and specific," says Kirsten Lindsmith, another blogger on autism. By speaking up when neurotypical people might just grin and bear it, she and others can improve the office environment for all. "You design better for the center when you learn from the margins," says Magda Mostafa of the American University in Cairo, an architect who focuses on design for autism.

A HARD PLACE TO WORK

AMONG ALL THE FINDINGS of office psychology studies over the decades, two stand out. The first is that the open office

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An open-plan office in London has a typical modern style, with harsh lighting, little privacy and spaces for employees packed closely together—all features that workers dislike.

actually makes it much harder for people to collaborate. In 1984 the Buffalo Organization for Social and Technological Innovation (BOSTI) reported on its survey of some 6,000 workers at about 70 sites. Respondents in open-plan offices said they held back on talking to one another so as not to disturb their neighbors or broach confidential subjects in public. Although the BOSTI survey relied on people's self-reported interactions, Ethan S. Bernstein and Stephen Turban of Harvard Business School corroborated it in 2018 with more objective measures. They had 152 workers at two companies wear sensors to track their movements. After moving from individual offices to an open plan, the workers spent only a third as much time interacting face-to-face as they had before, a striking downturn.

The second finding is that factors such as job function and gender influence how happy or unhappy people are with an open office. In early surveys, for instance, clerical workers said they were happier with an open office—it gave them someone to talk to while filing papers or transcribing memos. Women, however, have more recently reported a distressing fishbowl effect. In an intensive case study of a new open office in 2018, Hirst and Christina Schwabenland of the University of Bedfordshire in England found that women felt the new design put them on display and responded by dressing up. Some found the expectations oppressive and told the researchers that they were being stared at and judged. Several in senior management, though, said they welcomed the opportunity to signal their status through fashion, so in this sense the open office actually reinforced the corporate hierarchy.

Men did not express comparable concerns. "It's a reflection of a wider societal norm about who looks at whom," Hirst says. The management team that decided on the design of the office was made up of all men, and when Hirst and Schwabenland interviewed them, they mentioned gender only twice—and those comments were cringeworthy, such as remarks that an open office would make it harder to have an affair.

A spectrum of opinion also shows up when it comes to a design trend that became hot in the early 1990s: the nonterritorial office, in which workers have no assigned space at all. Some companies instituted a "hoteling" system, in which workers could reserve an office or desk for a set period. Others began "hot desking," in which workers had to scramble for spots like kids in a school cafeteria. By 2020 Gensler found that one in 10 knowledge workers in the U.S. had such an arrangement.

The nonterritorial office is simultaneously the most reviled and the best liked of arrangements. Gensler respondents without assigned desks were split down the middle. In 2008 Christina Bodin Danielsson of the Royal Institute of Technology and statistician Lennart Bodin (her father-in-law) of the Karolinska Institute, both in Stockholm, surveyed 469 employees at 26 local offices. Those in assigned-seat open offices reported the worst health and job satisfaction, whereas those in private offices and nonterritorial or "flex" offices reported the highest. "The flex office appears to be preferred over traditional open offices, and in some cases, it seems to even be better than the [private] office," Bodin Danielsson says. What workers in nonterritorial offices give up in personalization, they gain in control; they can join a communal table when they need to share ideas and retreat to a nook when they have to concentrate.

But there is an important proviso: offices need plenty of nooks. In 2019 Bodin Danielsson and Töres Theorell of Stockholm University studied hot-desking offices that skimped on breakout rooms or otherwise didn't have enough space for everyone to find a workspace to their liking, and employees were unhappier with this office type. When the goal is to pack in as many employees as possible, the nonterritorial

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DeafSpace, a design style developed at Gallaudet University, includes clear sight lines so deaf people can sign more easily (*top*), as well as translucent glass for some privacy (*bottom*).

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office loses whatever advantages it had.

Unfortunately, that is all too often the case. For a 2021 paper, Ingrid Nappi and Hajar Eddial, then both at the ESSEC Business School in the suburbs of Paris, interviewed 16 managers and consultants who make corporate real estate decisions. These people cited expenses such as rent and utilities as their primary reason for instituting hot desking or other nonterritorial features. They acknowledged that the savings could be offset by hidden costs such as lower productivity and more sick days, but these did not appear to factor into their decision.

DIFFERENT PEOPLE, DIFFERENT SPACES

ARCHITECTS AND DESIGNERS are coming around to the idea that one office size does not fit all. Since the 1990s they have been structuring offices as a quilt work of "neighborhoods," customizing workspaces by company department. Accountants might get a conventional mix of workstations and conference rooms, whereas marketing people are all about the sofas and whiteboards. "That's a much more tailor-made solution," says Alonso Toledo, a strategy director at Gensler in San Francisco. He says his team designs the neighborhoods based on employee surveys and day-in-the-life narratives.

Paying attention to natural human variation is a core principle for designers working with Deaf, neurodiversity and disabilities advocates. Mostafa and others who plan spaces for these groups argue that their work can inform office design more broadly. The failings of the open office are typically sensory, such as noise, headache-inducing lights and visual cacophony—the very things that deaf and autistic people are sensitive to. Neurotypical people may find it expedient to make do rather than make a fuss, but deaf and autistic people are closer to their edge of tolerance.

Deaf people have a lot of experience with figuring out how to make open floor plans just right. They often prefer an open plan because it gives them clear views of other people for signing. But they don't always want too much openness, because movement in the background can keep drawing their attention and lead to eye fatigue. When the balance of sight lines is right, "there's an emphasis placed on always seeing one another and knowing where others are in space and being able to have connection to the other," says Hansel Bauman, a designer in Washington, D.C., whose team at Gallaudet University developed architecture called DeafSpace. "I think there's a similarity there be-

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tween what is a desire within the Deaf community and, historically, where people have been with the creative office."

Robert T. Sirvage is a design researcher who worked with Bauman to develop DeafSpace and identifies as DeafBlind. (He is deaf and visually impaired.) Sirvage contrasts two architecture firms where he has worked. The first had a large, hangarlike space fitted out with rows of workstations. "In general, I don't love rows—I will say that," he says. "But in that setup, it was great." Each team occupied a row. People could go home and leave papers and blueprints scattered around in collaborative workspaces; there was no leave-it-so-someone-else-can-use-it policy. The coherent spatial organization made it easier for Sirvage to work with hearing colleagues who didn't sign. "If I can just point over in that direction, and we know what that direction is, and what's there, and what that means, then we have a common schema," he says. The second office lacked this clarity. It was stylish but labyrinthine and didn't provide each team a dedicated meeting space. "It was hard to know what the focus of different spaces was," he says.

Yushi Zhang of Yale University, who is neurodivergent, has her own tale of two offices. She worked at a newspaper in Chengdu, China, that had a huge, wide-open bullpen office, which people on the autism spectrum often describe as their nightmare. Yet she felt comfortable because the background noise was low and large windows provided natural lighting. Later, she moved to the U.S. and worked for an insurance company in a cubicle farm without much natural light. She had more privacy than before, but that also meant her interchanges with co-workers never got past small talk, which she and many other autistic people loathe. "Ask me 'How are you?'—when I first came here, I really didn't know how to answer that question," she says. "I would be standing there, wondering, 'Are you really wanting to know how I'm doing?'" She missed having natural lighting, too. "I feel like the bright light is too loud," she recalls. "It's screaming to me. It's like my ear hurts." She quit after three months.

Bauman and Mostafa both consult for the New York–based studio MIXdesign, where they merge the principles of designing for neurodiversity and for deafness. Reducing visual distractions and acoustic noise helps both autistic people and those who use hearing aids or cochlear implants. Adding breakout spaces along hallways and sidewalks lets autistic people take a breather and deaf people step out of the flow of traffic for a signed conversation.

Not every feature is a win-win, though. Making a room hypertransparent for people who are deaf may overstimulate people who are autistic. Widening a hallway to give people who are deaf more room to sign may make it harder for people who are blind to find their way. "Part of our philosophy in MIX is to ensure that that intersectional approach doesn't, by creating access to one cohort, create a barrier for another," Mostafa says. Often the best they can do is to create variety, so that everyone can find what they need—a spectrum of space.

LISTENING TO WORKERS

PERHAPS THE MOST IMPORTANT innovation of inclusive design is not the design itself but the process. Most people who have been through an office redesign get the feeling that companies solicit workers' views less to inform the design than to get them to acquiesce to whatever top management has already decided. Executives often "say, 'Low-level workers and ordinary workers really don't need to be included. We only need to give them the illusion of inclusion,'" notes Jennifer Kaufmann-Buhler, a design historian at Purdue University who has written a book on the adoption and spread of open offices.

Inclusive designers, in contrast, adopt the disabilities-rights principle of "nothing about us without us." The Deaf community, especially, has a strong ethos of inclusivity. Bauman describes what often happens when hard-of-hearing people go out for drinks after work. "First thing that happens is all the furniture gets moved. You've got to get so you can see each other; everyone's concerned about the lighting conditions and what the background is," he says. "Always the manager of the bar comes over and gets upset because you're moving the chairs." Bauman describes DeafSpace as this sense of agency writ large.

So far, though, he and his colleagues at MIXdesign have yet to demonstrate these principles in an actual office; their practice focuses on schools and museums. Even these institutions, which give a high priority to accessibility, have to justify the extra expense. So designers must make the case for a net benefit over the long term. "It's probably the single most challenging element of the work that we do," Mostafa says.

Toledo says he has encouraged companies to use the pandemic as an opportunity to evolve. "It seems to me a bit forced that we're assuming that there needs to *be* an office," he says. Some companies are going entirely virtual and building their human connections in other ways, such as regular staff retreats. A shared office can provide everyone with equal work resources, but there are other ways to perform that democratizing function, Toledo says. Many companies are now paying at-home employees for their Internet service and ergonomic chairs; some U.S. states even require it.

Putting these ideas together, Bauman sees a huge opportunity. With so many people working from home, companies need less office space, and building owners are considering converting offices to apartments. These spaces—both work and home—could easily be built to inclusive-design standards: plentiful natural lighting, quieter air-handling systems and, above all, variety.

There may be "places where you might limit visual exposure and visual access, and there's other places you might open up visual access," Bauman says. A single building might have a mix of apartments and coworking spaces, not only supporting diverse work patterns but also creating enclaves for people from the Deaf and neurodiverse communities, as well as others with particular needs. "It inherently has the ability to create communities for people of difference," he says.

Toledo emphasizes that no one is sure what the next stage in the evolution of the office will be. Businesses and workers will need to live with this uncertainty and embrace an experimental, trial-and-error spirit. "The planning that we do is always like the light from the stars," he says. "We are seeing the past." And hoping that we can avoid repeating its mistakes. ●

George Musser is a contributing editor at *Scientific American* and author of *Putting Ourselves Back in the Equation* (2023) and *Spooky Action at a Distance* (2015), both published by Farrar, Straus and Giroux. Follow him on Mastodon @gmusser@mastodon.social

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CONQU

Job satisfaction is surprisingly fragile. Here's how to

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UERING

protect yourself against the top contributors to burnout

BY MICHAEL P. LEITER AND CHRISTINA MASLACH

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YOU LIE IN BED in the morning, reluctant to swing your legs out from under the warm embrace of your blanket. After several bleary minutes, you finally rouse yourself, throw on some clothes and head to the office. Having arrived at your desk, you stare blankly as e-mail loads on your screen. When you first started this job, you derived deep satisfaction from addressing the day's challenges efficiently and artfully. Yet the optimism that used to buoy you is long gone. Now your morning coffee gives you the only jolt of energy you'll feel all day. The details differ by profession, but this state of being is the essence of burnout. It undoes a person's ability to pursue a happy, healthy and productive professional life.

Given that many of us spend the bulk of our waking hours at work, burnout can pose a real threat to overall well-being. Often it begins with pure exhaustion. When you are worn out, you invest less in your job. As a result, you accomplish fewer things and feel less effective than you did before. Because work has ceased to offer the same psychological rewards, you start to feel cynical about your role. These emotions—exhaustion, feelings of inefficacy and cynicism—feed off one another, producing a vicious cycle of deepening burnout.

So do you just quit? Quitting is probably not the answer, although you might want to look for a different job. To recover a professional joie de vivre, it helps to understand the basics of burnout from a psychological perspective. Decades of research have revealed several core truths about the syndrome. First, banish the idea that it arises from a personal failing. People who face burnout do not lack some essential quality such as work ethic, resilience or self-confidence. When all goes well, we naturally tend to bring dedication and pride to our work. Burnout represents the erosion of these noble qualities. Research has consistently pointed to management practices and poor job designs as the leading causes. The ways supervisors lead, and the structure of employees' workdays, fail to bring out the best in people.

If you suffer from burnout, your relationship with your job has gone sour. Just as a fight with a partner or close friend can exhaust you and cause you to pull away from that person, so can a soured relationship with your job sap your enthusiasm and alienate you. Relationships are complicated things, however, so there is no single solution, no magic bullet, no "one size fits all" approach. Yet with patience and optimism, anyone can find a path back to engagement.

THE RISE OF BURNOUT

THE USE OF THE TERM "burnout" began gaining popularity in the 1970s, especially among people working in human services. Herbert Freudenberger, a psychologist at an alternative mental health agency, and one of us (Maslach) wrote early articles describing idealistic young professionals in health care and social work who were overextending themselves. They felt discouraged because they did not have sufficient resources to do their jobs well. Instead of building a better world, they felt they were marking time in a dysfunctional system.

The global pandemic that began in 2020 disrupted work life, increasing the intensity for some while decreasing the intensity for others. Everyone was affected. Imposed changes to work, such as shifts from meeting in person to online meetings, classes or interviews, can weaken a person's sense of efficacy. In addition to workload, responding to disruptions in itself drains energy. Concerns about personal safety can increase cynicism. An understandable rise in the dimensions of burnout need not endure, but it is essential that employers support employees as they manage these disruptions to their work life. With experience, people adapt to change, learning ways to create a fulfilling life at work.

Based on research evidence accumulated over several decades, in 2019 the World Health Organization (WHO) defined burnout as "a syndrome conceptualized as resulting from chronic workplace stress that has not been successfully managed. It is characterized by three dimensions: feelings of energy depletion or exhaustion; increased mental distance from one's job, or feelings of negativism or cynicism related

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to one's job; and reduced professional efficacy." The WHO also stated that it recognized burnout as an "occupational phenomenon" and declared emphatically that "it is not classified as a medical condition."

Ultimately the true culprit is a mismatch between a person and the circumstances of a job. You might not have the resources you need, or your bosses might expect you to complete a task in a way that clashes with your principles. For example, health-care providers in our surveys often cite tensions between their professional ideals—to be emotionally supportive to their patients—and the constraints that undermine that goal, namely, insufficient staffing and outsized workloads. The quantity of work is important, but the real trouble arises from employees' perception of their own performance.

Another type of mismatch stems from lack of control. Letting people make decisions about how they spend their days is vital to a healthy work arrangement, but a sense of control can be easily eroded. Managers who set unrealistic expectations for an employee contribute to attrition. So do colleagues who do not communicate well. We all rely on others while doing our jobs, and poor communication can make our workdays more difficult and unpredictable than they need to be. When people feel they lack control over their own work, they are particularly prone to feeling cynical and ineffectual.

Bosses who fail to express their appreciation also contribute to workers' feelings of inefficacy. Indeed, we have found in our research that negative interactions with a supervisor incline a person toward burnout. Yet not all praise is created equal. We worked with one organization in which employees resented an employee-of-the-year award. The rank and file perceived the accolade as an indicator of who was in the good graces of company leaders and little else. Seemingly inequitable promotions can similarly harm engagement. In a 2014 survey that one of us (Leiter) conducted of people's feelings of burnout, one respondent wrote, "It is difficult to watch the randomness of why some are promoted and others are ignored. It drains the spirit from you." That interviewee directly linked a feeling of being unappreciated with a loss of energy—a strong indication of burnout.

EARLY WARNING SIGNS

THE EMOTIONAL DISTRESS of this syndrome can persist for years. Because it can become chronic, we grew interested in discovering whether we might predict—and thus potentially ward off—the emergence of burnout. In a study published in 2008, we surveyed 446 employees of an administrative department at a large university, first at the beginning of our investigation and again a year later. We probed numerous areas of their work life to assess burnout. We were curious to see how people who scored high on one dimension—say, high cynicism or high exhaustion—would rate a year later. If they became more burned out, we wanted to know what tipping point might have sent them in that direction.

As it turned out, we found one such indicator: workplace fairness. People who perceived favoritism, cheating or other inequities were more likely to be burned out by the end of our study. Conversely, employees who viewed the workplace as a just environment tilted back toward engagement. A fluke event during the year of our study brought the issue of fairness into stark relief. Investigators uncovered department members who were stealing from their workplace. Our final survey occurred soon after a few employees were apprehended and dismissed, so we could assess how disruptive this event had been. The thefts undermined trust among colleagues, weakened employees' sense of job security and, as a result, deepened burnout.

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Recent developments have distinguished burnout from other distressed states. Our research has identified three profiles in addition to the distressed "burnout" profile (exhaustion, cynicism, inefficacy) and its opposite, the positive "engaged" profile (energy, involvement, efficacy). The "overextended" profile seems similar to burnout in its high level of exhaustion but differs importantly by having lower levels of cynicism and inefficacy. The "disengaged" profile, in contrast, has high levels of cynicism but relatively low levels of exhaustion and inefficacy. People in the "ineffective" profile feel energetic and involved but lack a sense of professional efficacy.

These distinctions matter. Research revealed that people in the overextended profile had one overriding concern: work overload. They gave every indication that with effective help managing their workload, they would move toward the engaged profile. In contrast, people in the burnout profile had many concerns beyond work overload, such as control, community, reward and fairness. They seriously doubted any alignment of their workplace values with their personal or professional values. Making a difference for them would be a much bigger job. A more precise definition of the problem can facilitate more effective solutions.

THE SOCIAL SOLUTION

BECAUSE BURNOUT DEPENDS heavily on the specific relationship between person and job, broad guidelines for recovery are hard to come by. Nevertheless, we now believe that improving the quality of workplace relationships may be one general way to intervene. Social exchanges between colleagues play a role in many facets of burnout.

As you might expect, people share more readily with individuals they admire and trust. Conversely, hostile workplaces eat away at people's ability to focus on their work. Consider, for example, this anecdote, also from Leiter's 2014 survey, in which one employee articulates the energy tax of negative interactions: "I love my work. I am an avid learner and a very positive person. But I work in a toxic workplace. This is a highly political environment that encourages competition between colleagues, backstabbing, gossiping and hiding information. I find going to work very difficult and come home exhausted." Other participants in our studies have similarly cited the emotional toll of unpleasant interactions. They describe feeling upset for days following a few rude words from a colleague and losing sleep over the incident—both factors that make it difficult to engage in what otherwise might be pleasurable tasks.

An opportunity to alleviate burnout arose in a meeting with leaders of a hospital in 2016. These executives had taken reasonable action to strengthen the sense of community in struggling work groups, including by changing team leaders and reassigning or dismissing identified troublemakers. Managers had brought in inspirational speakers and conducted team-building exercises. All of this effort met with minimal success.

To tackle this problem, Leiter and his research team built on their previous work on work-group-based civility programs to develop a new method called SCORE (Strengthening a Culture of Respect and Engagement). This focused process, occur-

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ring over five sessions, delivers a structured curriculum. The Leiter team's previous research had demonstrated that guiding work groups to reflect on their social encounters can improve civility, with the downstream benefit of alleviating burnout.

Knowing that burnout has a social angle, we deployed a work-group civility process in several units of the hospital. Some of these units had a long history of problems, others were uncommunicative, and some functioned well but aspired to collaborate more. Employees were divided into groups of 15 to 20 people from their same unit. With larger units, we offered the sessions multiple times. A professional facilitator from a local consulting firm guided the sessions, with assistance from a co-facilitator who was an employee of the participating organization.

Before we began, we surveyed all our participants on their perceptions of civility in their unit and on their own conduct so that we could compare their impressions at the beginning and the end of the program. We also assessed the dimensions of job burnout.

Over two or three months the teams met five times with three weeks between sessions. The facilitator started off the first session by asking, "How do we show respect (or disrespect) for one another here?" Then attendees practiced enacting civil exchanges, showing acceptance, acknowledgment, appreciation and accommodation of one another. Later sessions addressed responding to incivility, as well as promoting civility within their work groups.

The meetings gave employees a chance to work through strained relationships and engage in more productive ways of defusing emotions. Between sessions, workers practiced specific civility behaviors and tallied acts of kindness they witnessed.

The project has continued in other health-care settings, as well as in financial institutions, a radio station, and police and fire departments. The research on work-group-focused civility programs over the past decade confirms that they bring improvements in both workplace civility and burnout. Implementing the program across a variety of settings identifies the mechanisms that help work groups free themselves from dysfunctional social dynamics.

The SCORE approach reflects actions that arise from considering burnout as a relationship problem. Social encounters with colleagues, especially with supervisors, create points at which the work-group culture becomes personal. Infusing these encounters with respect inspires energy, involvement and efficacy—the opposite of burnout.

FINDING ENGAGEMENT

GIVEN THAT NOT EVERY COMPANY is about to start implementing SCORE, what is an individual worker to do? Many corporations may see squeezing every bit out of employees to be to their advantage. Organizations by and large do not expect to retain their employees forever, so they are unlikely to serve their workers' long-term interests. Employees thus must shoulder the responsibility of maintaining a sustainable work environment.

How employees define their relationship with work gives us insight into their larger aspirations for work. How much control do they desire, knowing control brings accountability? Is being fully involved in a vibrant workplace community essential? Most centrally, what are the core values that define a meaningful work life? In other words, establishing a fulfilling relationship with work becomes more likely for people who know what they are seeking. Such insight allows people to make their case.

Because burnout is a relationship issue, the individual has some, but not complete, control over circumstances. What follows are a few basic strategies for improving your contribution to the relationship. The good news is that many of these suggestions happen to be good for life in general, so you will benefit in many ways from developing these habits.

First up is fitness. A healthy way of life increases your resilience. A combination of sufficient exercise, nutrition and sleep will reduce your vulnerability to exhaustion. Although the job will not change, you will increase your endurance—and maybe even learn to thrive.

Closely related to fitness is a habit of integrating recovery cycles into your life. Demanding work depletes your physical, emotional and cognitive resources. As the saying goes, there is a reason it is called work. Your personal life should afford opportunities to enjoy relationships, catch up on sleep and take time for reflection. To reverse a trend toward burnout, a key step is to establish a firm structure for recovery activities. Lacking a structure, you will not make time for recovery in the course of a busy life.

You can incorporate small amounts of exercise and recovery into the workday, too. The strategy here is simple: get off your butt. Set an alarm to go off every 30 minutes as a signal to get up and walk around. You can devise some activities that would convince an observer that this meandering is a necessary part of your work.

Now let us incorporate the social angle. As we demonstrated with SCORE, improving the quality of day-to-day exchanges among colleagues reduces burnout. You do not need your entire team to join you on this journey, but if you can recruit a friend or two to share a burnout-reduction project (a short midday walk, perhaps) the mutual support can be powerful.

Receiving good vibes from others is an uplifting experience, but so, too, is expressing them to others. Keep a tally of your own acts of kindness toward colleagues. To whom did you express appreciation today? Collaborating with a companion will, again, help you get the most out of this project.

Last, consider job crafting. You very likely have more latitude in your work than you think. Job crafting is an analytic approach that involves identifying the duties you find tedious and the aspects you find fulfilling. You should develop a plan to spend a bit more of your day on the good parts. Those increments can add up over time. Just ensure that the additional time you are spending on the fulfilling tasks makes a meaningful contribution, so as to keep your colleagues and supervisor onboard.

These ideas may sound like a big investment, but the truth is that burnout can be hard to shake. Once the syndrome has set in, you must commit to a deliberate practice to find your way back to a healthy, fulfilling relationship with work. Yet it can be done, so let's get started. ●

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Christina Maslach is a professor of psychology at the University of California, Berkeley.

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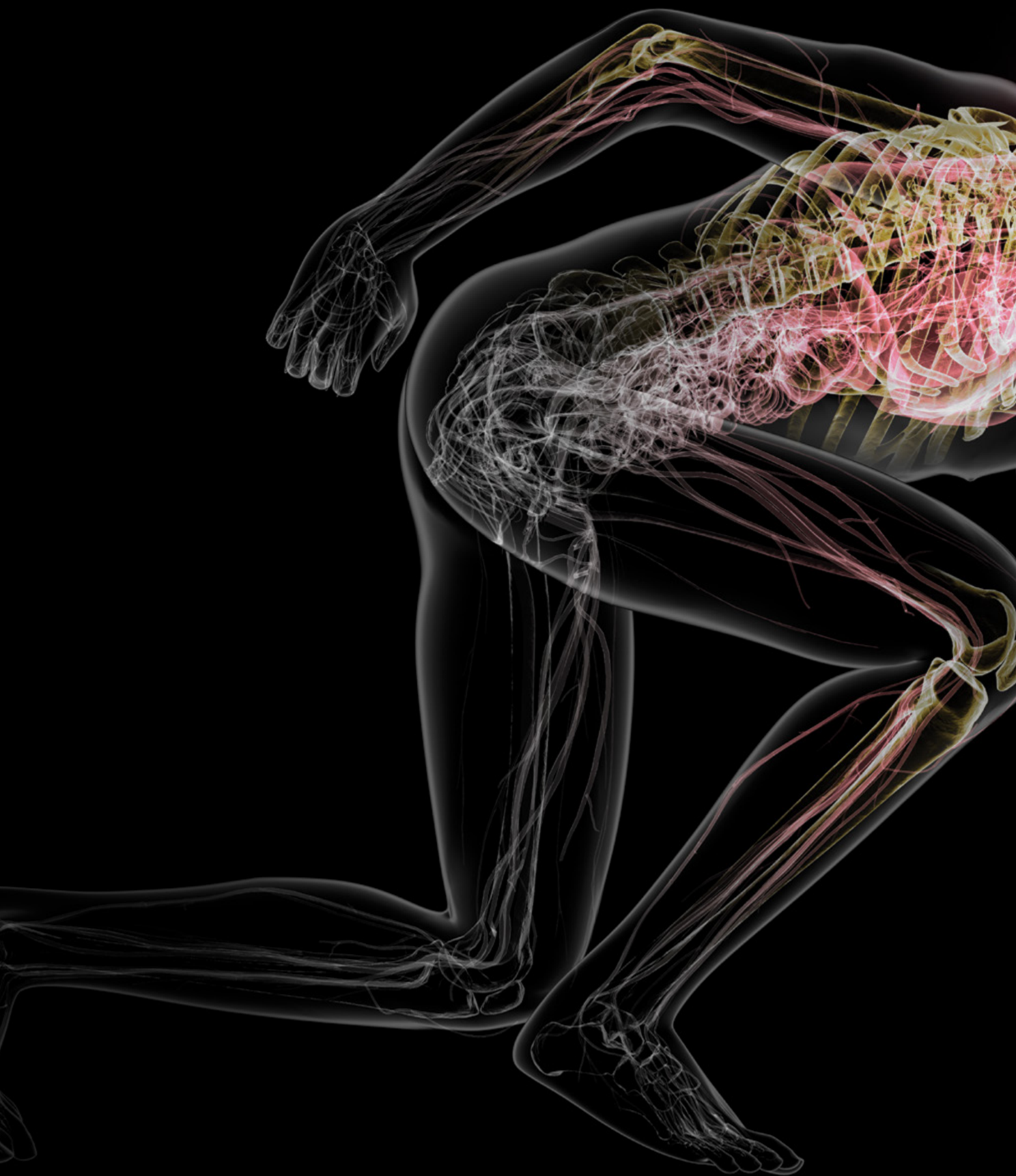

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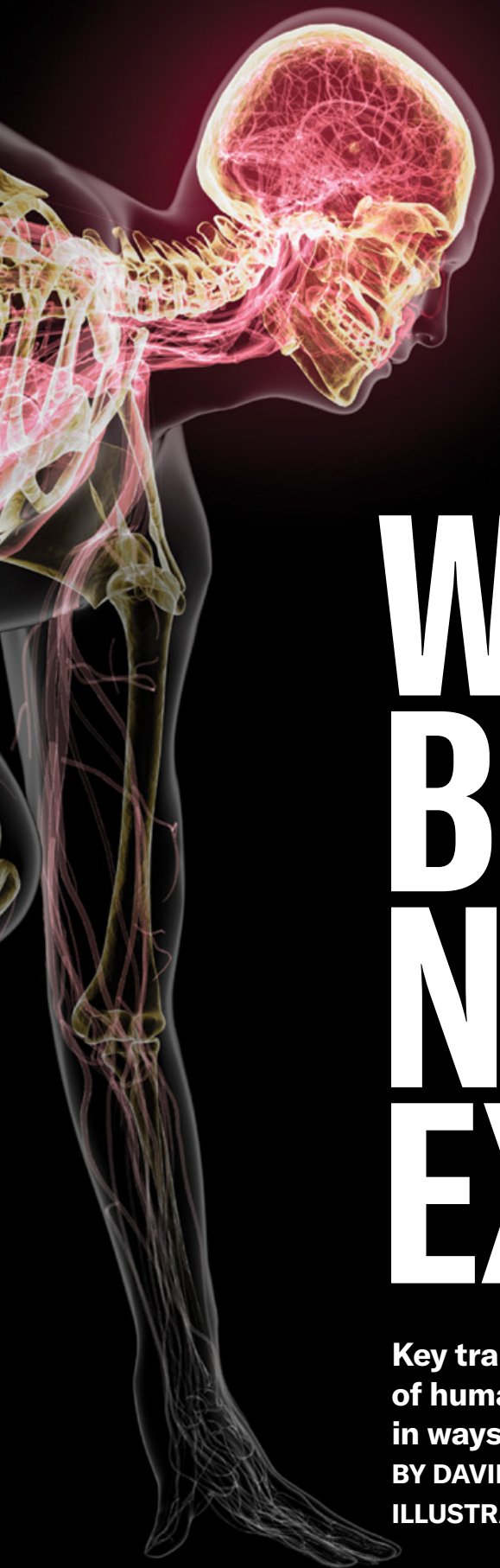

WHY YOUR BRAIN NEEDS EXERCISE

Key transitions in the evolutionary history of humans may have linked body and mind in ways that we can exploit to slow brain aging

BY DAVID A. RAICHLEN AND GENE E. ALEXANDER

ILLUSTRATION BY VIOLET FRANCES

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IN THE 1990S researchers announced a series of discoveries that would upend a bedrock tenet of neuroscience. For decades the mature brain was understood to be incapable of growing new neurons. Once an individual reached adulthood, the thinking went, the brain began losing neurons rather than gaining them. But evidence was building that the adult brain could, in fact, generate new neurons. In one particularly striking experiment with mice, scientists found that simply running on a wheel led to the birth of new neurons in the hippocampus, a brain structure that is associated with memory. Since then, other studies have established that exercise also has positive effects on the brains of humans, especially as we age, and that it may even help reduce the risk of Alzheimer's disease and other neurodegenerative conditions. But the research raised a key question: Why does exercise affect the brain at all?

Physical activity improves the function of many organ systems in the body, but the effects are usually linked to better athletic performance. For example, when you walk or run, your muscles demand more oxygen, and over time your cardiovascular system responds by increasing the size of the heart and building new blood vessels. The cardiovascular changes are primarily a response to the physical challenges of exercise, which can enhance endurance. But what challenge elicits a response from the brain?

Answering this question requires that we rethink our views of exercise. People often consider walking and running to be activities that the body is able to perform on autopilot. But research carried out in recent decades by us and others would indicate that this folk wisdom is wrong. Instead exercise seems to be as much a cognitive activity as a physical one. In fact, this link between physical activity and brain health may trace back millions of years to the origin of hallmark traits of humankind. If we can better understand why and how exercise engages the brain, perhaps we can leverage the relevant physiological pathways to design novel exercise routines that will boost people's cognition as they age—work that we have begun to undertake.

FLEXING THE BRAIN

TO EXPLORE WHY exercise benefits the brain, we need to first consider which aspects of brain structure and cognition seem most responsive to it. When researchers led by Fred Gage and Henriette Van Praag, both then at the Salk Institute for Biological Studies in La Jolla, Calif., showed in the 1990s that running increased the birth of new hippocampal neurons in mice, they noted that this process appeared to be tied to the production of a protein called brain-derived neurotrophic factor (BDNF). BDNF is produced throughout the body and in the brain, and it promotes both the growth and the survival of nascent neurons. The Salk group and others went on to demonstrate that exercise-induced neurogenesis is associated with improved performance on memory-related tasks in rodents. The results of these studies were striking because atrophy of the hippocampus is widely linked to memory difficulties during healthy human aging and occurs to a greater extent in individuals with neurodegenerative diseases such as Alzheimer's. The findings in rodents provided an initial glimpse of how exercise could counter this decline.

Following up on this work in animals, researchers carried out a series of investigations that determined that in humans, just like in rodents, aerobic exercise leads to the production of BDNF and augments the structure—that is, the size and connectivity—of key areas of the brain, including the hippocampus. In a randomized trial conducted at the University of Illinois at Urbana-Champaign by Kirk Erickson (now at the University of Pittsburgh) and Arthur Kramer, 12 months of aerobic exercise led to an increase in BDNF levels, an increase in the size of the hippocampus and improvements in memory in older adults.

Other investigators have found associations between exercise and the hippocampus in a variety of observational studies. In our own study of more than 7,000 middle-aged to older adults in the U.K., published in 2019 in *Brain Imaging and Behavior,* we demon-

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strated that people who spent more time engaged in moderate to vigorous physical activity had larger hippocampal volumes. Although it was not possible for us to say whether these effects in humans are related to neurogenesis or other forms of brain plasticity, such as increasing connections among existing neurons, together the results clearly indicated that exercise can benefit the brain's hippocampus and its cognitive functions.

Researchers have also documented clear links between aerobic exercise and benefits to other parts of the brain, including expansion of the prefrontal cortex, which sits just behind the forehead. Such augmentation of this region has been tied to sharper executive cognitive functions, which involve aspects of planning, decision-making and multitasking—abilities that, like memory, tend to decline with healthy aging and are further degraded in the presence of Alzheimer's. Scientists suspect that increased connections between existing neurons, rather than the birth of new neurons, are responsible for the beneficial effects of exercise on the prefrontal cortex and other brain regions outside the hippocampus.

UPRIGHT AND ACTIVE

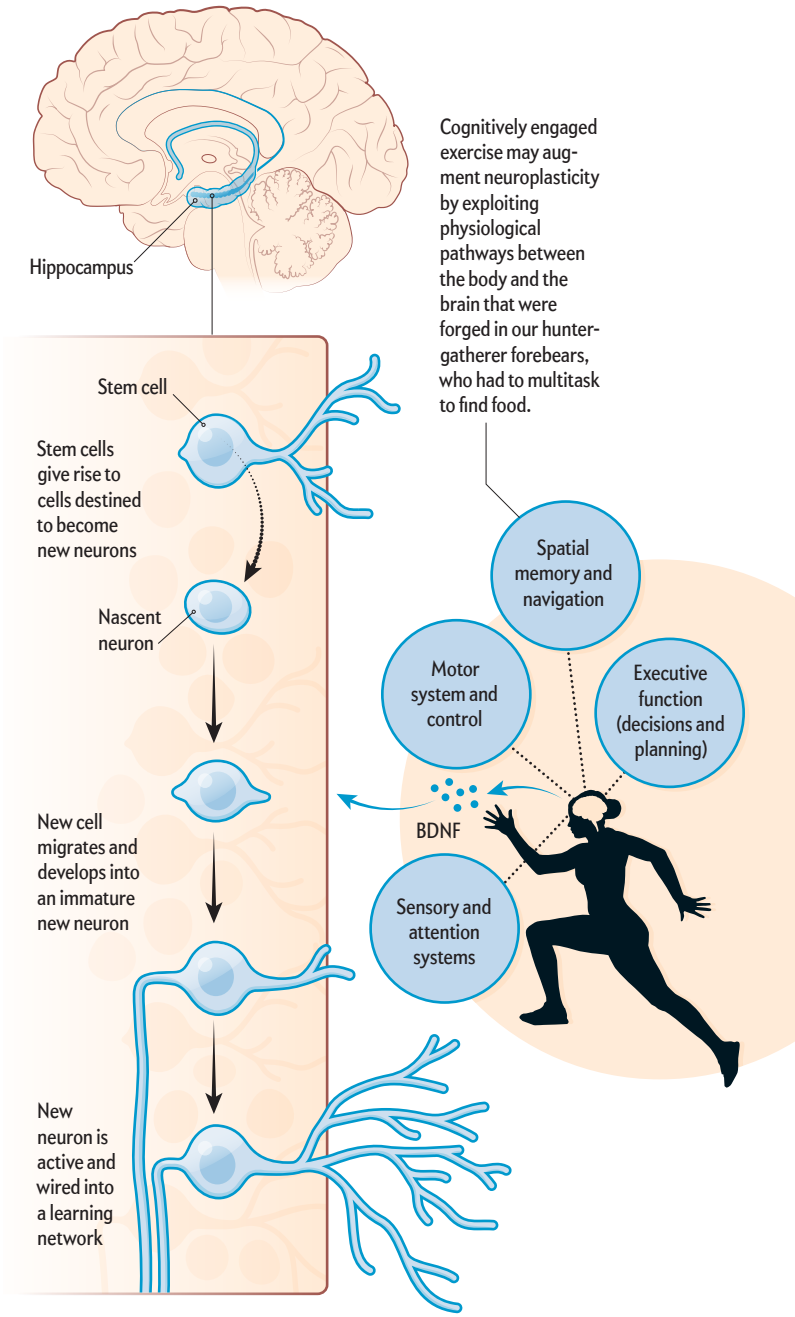
WITH MOUNTING EVIDENCE that aerobic exercise can boost brain health, especially in older adults, the next step was to figure out exactly what cognitive challenges physical activity poses that trigger this adaptive response. We began to think that examining the evolutionary relation between the brain and the body might be a good place to start. Hominins (the group that includes modern humans and our close extinct relatives) split from the lineage leading to our closest living relatives, chimpanzees and bonobos, between six million and seven million years ago. In that time, hominins evolved a number of anatomical and behavioral adaptations that distinguish us from other primates. We think two of these evolutionary changes in particular bound exercise to brain function in ways that people can make use of today.

First, our ancestors shifted from walking on all fours to walking upright on just their hind legs. This bipedal posture means that there are times when our bodies are precariously balanced over one foot rather than two or more limbs like in other apes. To accomplish this task, our brains must coordinate a great deal of information and, in the process, make adjustments to muscle activity throughout the body to maintain our balance. While coordinating these actions, we must also watch out for any environmental obstacles. In other words, simply because we are bipedal, our brains may be more cognitively challenged than those of our quadrupedal ancestors.

Second, the hominin way of life changed to incorporate higher levels of aerobic activity. Fossil evidence indicates that in the early stages of human evolution,

New Neurons in Aging Brains

Exercise leads to beneficial changes in the adult brain, including the birth of new neurons and increased connections among existing neurons. One of the ways in which physical activity seems to induce this neuroplasticity is by increasing production of a protein called brain-derived neurotrophic factor (BDNF), which promotes neuron growth and survival. Recent research suggests that cognitively engaging the brain during physical activity enhances this process.


Hippocampus
Cognitively engaged exercise may augment neuroplasticity by exploiting physiological pathways between the body and the brain that were forged in our hunter-gatherer forebears, who had to multitask to find food.
Stem cell
Stem cells give rise to cells destined to become new neurons
Nascent neuron
New cell migrates and develops into an immature new neuron
New neuron is active and wired into a learning network
Spatial memory and navigation
Motor system and control
Executive function (decisions and planning)
BDNF
Sensory and attention systems

Graphics by Tami Tolpa

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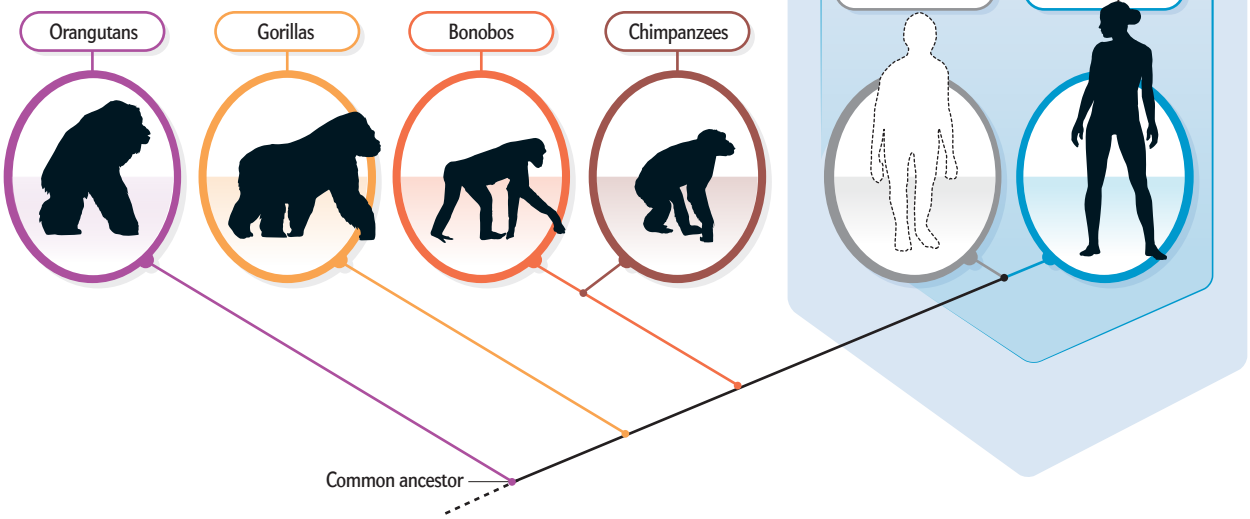
Up and at 'Em

In the six million to seven million years since the human lineage diverged from that of the chimpanzees and bonobos, our kind has evolved a host of characteristics that set us apart from other apes. The beneficial effects of cognitively engaged exercise on the brain may stem from two evolutionary changes in particular that made humans more physically active than our ape cousins and supercharged our ability to multitask: the shift to upright walking and the adoption of hunting and gathering as a subsistence strategy.



Bipedalism

By around six million to seven million years ago human ancestors had abandoned walking on all fours for striding upright on their hind limbs like us. The shift from quadrupedal to bipedal locomotion introduced balance challenges that may have placed new demands on the brain.

Hunting and Gathering

Some two million years ago our ancestors began to forage in a new way, hunting animals and gathering plant foods. This strategy involves far more aerobic activity than is seen in other apes, which subsist mainly on plants. And it requires that the brain carry out an array of cognitive tasks while on the move.

our ancestors were probably relatively sedentary bipedal apes who ate mainly plants. By some two million years ago, however, as habitats dried out under a cooling climate, at least one group of ancestral humans began to forage in a new way, hunting animals and gathering plant foods. Hunting and gathering dominated human subsistence strategies for nearly two million years until the advent of farming and herding around 10,000 years ago. With Herman Pontzer of Duke University and Brian Wood of the University of California, Los Angeles, we have shown that because of the long distances traversed in search of food, hunting and gathering involves much more aerobic activity than seen in other apes.

Increased demands on the brain accompanied this shift toward a more physically active routine. When out foraging afar, hunter-gatherers must survey their surroundings to make sure they know where they are. This kind of spatial navigation relies on the hippocampus, the same brain region that benefits from exercise and that tends to atrophy as we get older. In addition, they have to scan the landscape for signs of food, using sensory information from their visual and auditory systems. They must remember where they have been before and when certain kinds of food were available. The brain uses this information from both short- and long-term memory, allowing people to make decisions and plan their routes—cognitive tasks that are supported by the hippocampus and the prefrontal cortex, among other regions. Hunter-gatherers also often forage in groups, in which case they may have conversations while their brains are maintaining their balance and keeping them spatially located in their environment. All of this multitasking is controlled, in part, by the prefrontal cortex, which also tends to diminish with age.

Although any foraging animal must navigate and figure out where to find food, hunter-gatherers have to perform these functions during fast-paced treks that can extend over more than 20 kilometers. At high speeds, multitasking becomes even more difficult and requires faster information processing. From an evolutionary perspective, it would make sense to have a brain ready to respond to an array of challenges during and after foraging to maximize the chances of success in finding food. But the physiological resources required to build and maintain such a brain—including those that support the birth and survival of new neurons—cost the body energy, meaning that if we do not regularly make use of this system, we are likely to lose these benefits.

This evolutionary neuroscience perspective on exercise and the brain, which we detailed in an article published in 2017 in *Trends in Neurosciences,* has profound implications for humans today. In our modern society, we do not need to engage in aerobic physical activity to find food for survival. The brain atrophy and attendant cognitive declines that commonly occur during aging may be partly related to our sedentary habits.

But simply exercising more may not realize the full potential of physical activity for keeping brain decline at bay. Indeed, our

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model suggests that even people who already get a lot of aerobic activity may want to rethink their routines. It is possible that we might not always exercise in ways that take full advantage of our evolved mechanisms for sustaining brain performance.

Think about the ways in which many of us get our aerobic exercise. Often we go to gyms and use a stationary exercise machine; the most cognitively demanding task in such a workout might be deciding what channel to watch on the built-in television. What is more, these machines remove some of the demands of maintaining balance and adjusting speed, among many other intrinsic cognitive challenges of movement through a changing environment.

What if this form of exercise is shortchanging us? Our ancestors evolved in an unpredictable world. What if we could modify our exercise routines to include cognitive challenges like those faced by our hunter-gatherer forebears? If we can augment the effects of exercise by including a cognitively demanding activity, then perhaps we can increase the efficacy of exercise regimens aimed at boosting cognition during aging and potentially even alter the course of neurodegenerative diseases such as Alzheimer's.

MOVE AND THINK

IN FACT, a growing body of research suggests that exercise that is cognitively stimulating may indeed benefit the brain more than exercise that does not make such cognitive demands. For example, Gerd Kempermann and his colleagues at the Center for Regenerative Therapies Dresden in Germany explored this possibility by comparing the growth and survival of new neurons in the mouse hippocampus after exercise alone or after exercise combined with access to a cognitively enriched environment. They found an additive effect: exercise alone was good for the hippocampus, but combining physical activity with cognitive demands in a stimulating environment was even better, leading to even more new neurons. Using the brain during and after exercise seemed to trigger enhanced neuron survival.

We and others have begun to extend these studies from animals to humans—with encouraging results. For example, researchers have explored combining exercise and cognitive challenges in individuals experiencing notable cognitive decline. Cay Anderson-Hanley of Union College in Schenectady, N.Y., has tested simultaneous exercise and cognitive interventions in people with mild cognitive impairment, a condition associated with increased risk for Alzheimer's. More work certainly needs to be done in populations such as this one before we can draw any firm conclusions, but the results so far suggest that people who are already experiencing some cognitive decline may benefit from exercising while playing a mentally demanding video game. In studies of healthy adults, Anderson-Hanley and her colleagues have also shown that simultaneously exercising and playing a cognitively challenging video game may elicit a greater increase in circulating BDNF than exercise alone. These findings further bolster the idea that BDNF is instrumental in bringing about exercise-induced brain benefits.

In our own work, we have developed a game designed to specifically challenge aspects of cognition that tend to decline with age and that are probably needed during foraging. In the game, players spatially navigate and complete attention and memory tasks while cycling at a moderate aerobic intensity level. To evaluate the potential of this approach to boost cognitive performance in healthy older adults, we compared a group exercising while playing the game with a group exercising without the game, a group playing the game without exercising, and a control group that only watches nature videos. We have seen some promising results.

Brain atrophy and cognitive declines that commonly occur during aging may be related to sedentary habits.

Many other research groups have tested combinations of exercise and cognitive tasks. In the near future, we will probably have a better idea of how best to deploy them to support and enhance cognition in both healthy individuals and those experiencing disease-related cognitive decline.

In addition to specially designed interventions similar to the ones described here, it is possible that participation in sports that require combinations of cognitive and aerobic tasks may be a way to activate these brain benefits. For example, we showed that collegiate cross-country runners who train extensively on outdoor trails have increased connectivity among brain regions associated with executive cognitive functions compared with healthy but more sedentary young adults. Future work will help us understand whether these benefits are also greater than those seen in runners who train in less complex settings—on a treadmill, for instance.

Much remains to be discovered. Although it is still too early to make specific prescriptions for combining exercise and cognitive tasks, we can say with certainty that exercise is a key player in preserving brain function as we age. The U.S. Department of Health and Human Services guidelines suggest that people should engage in aerobic exercise for at least 150 minutes a week at a moderate intensity or at least 75 minutes a week at a vigorous intensity (or an equivalent combination of the two). Meeting or exceeding these exercise recommendations is good for the body and may improve brain health.

Clinical trials will tell us much more about the efficacy of cognitively engaged exercise—what kinds of mental and physical activities are most impactful, for example, and the optimal intensity and duration of exercise for augmenting cognition. But in light of the evidence we have so far, we believe that with continued careful research we can target physiological pathways linking the brain and the body and exploit our brain's evolved adaptive capacity for exercise-induced plasticity during aging. In the end, working out both the body and the brain during exercise may help keep the mind sharp for life. ●

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TREATING PATIENTS WITHOUT THE SCALE

Focusing on weight loss isn't making people healthier. Some doctors are trying a different approach

BY VIRGINIA SOLE-SMITH

PHOTOGRAPHS BY DAN SAELINGER

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THE WAITING ROOM at the Mosaic Comprehensive Care clinic in Chapel Hill, N.C., is as generic as any doctor's office except for a framed sign by the door. "No Wrong Way to Have a Body," it says, above an illustration of different cactus species. The second anomaly of this primary care practice is what is missing from the exam rooms: there are no scales. Louise Metz, the clinic's owner and founder, keeps just one on the premises, tucked in a back hallway. Most patients never even know it is there.

Erin Towne, 37 at the time of this annual physical, does know about the scale; she will stand on it during her examination so Metz can check whether she is continuing to restore her weight after recovering from a restrictive eating disorder. But only Metz will see the number. Towne, a mother and an IT worker, is tall and slender, a runner. She wears a long sundress and hunches slightly as she sits in one of the exam room's armless chairs. The chairs are designed to support heavy people comfortably, and not so long ago Towne would have been grateful to see them. This willowy body is still relatively new to her. In January 2017 she underwent bariatric surgery, and she lost 160 pounds.

For most of her life, Towne says, "all of my health care has been focused on me losing weight." After a series of blood sugar spikes at 13 years old, Towne was diagnosed with type 1 diabetes and started getting daily insulin injections. She was an average-sized kid, but her endocrinologist immediately suggested that she lose 10 to 15 pounds—a dictum that became the refrain of every doctor Towne saw as she grew older. It did not seem to matter that her diabetes was well controlled with a very low level of insulin; research dating back to the 1990s has shown an association between weight loss and better blood glucose management for diabetics, so weight-loss protocols are standard. Towne had been dieting since she was a teenager but never sustained the losses for long.

In 2016 Towne saw a new endocrinologist who changed her diagnosis to maturity-onset diabetes of the young, an inherited form of the condition. Even with an accurate diagnosis—and with confirmation that her diabetes was genetic in origin, not linked to weight—the fixation on making her smaller persisted, Towne says. Her doctor prescribed a diabetes medication called Victoza, which is also used off-label for weight loss. Towne tried it for a month but experienced acid reflux so severe that she could not go to work. At that point bariatric surgery seemed inevitable. "I couldn't seem to keep the weight off any other way," she says. "I had confidence that I could take care of my diabetes, but it seemed like no one else could split those two things apart."

Within six months of her bariatric surgery, Towne's body mass index (BMI) had dropped to 19.1, which is at the low end of the "normal" range for a person her height. In May 2017 Towne was able to stop using her insulin pump, a victory her endocrinologist attributed to her weight loss. At a follow-up appointment in her surgeon's office in December 2017, a physician assistant seemed thrilled with the results. "Congratulations, you can eat extra cookies over the holidays!" Towne recalls the PA telling her. But Towne felt out of control around food. She had become obsessed with tracking exercise and calories on fitness apps. "I was restricting so intensely that my body was in emergency mode," she says. "I would stand in front of my kitchen cabinets and picture myself eating everything in there." A few weeks later Towne sought help from a therapist, who diagnosed her with anorexia and referred her to the Mosaic clinic for medical supervision during her recovery. Towne did not quite believe her therapist at first: "The idea that I had a restrictive eating disorder was mind-blowing," she says. "I thought I was just doing what I'd always been told to do."

Unlike Towne's previous doctors, Metz did not praise her patient's dramatic weight loss. In fact, Metz, an internal medicine physician, is suspicious of the long-held belief that weight loss is necessary for optimal diabetes care. "The studies that associate weight loss with improvements in A1C [a blood glucose measurement] are asking the wrong question," she says. Weight may go down temporarily with a restrictive diet, but she believes that it is the changes in eating habits and exercise that cause the improvement, not the pounds lost. "And if those behavioral changes are too restrictive," Metz adds, "they may make the problem worse."

After taking Towne's history, Metz ordered an electrocardiogram—and then repeated it three times to confirm that Towne's resting heart rate had dropped into the low 50s, well below the normal range of 60 to 100 beats per minute. (Although low heart rates are considered healthy in endurance athletes, they are often a dangerous complication of severe weight loss and malnutrition, which can also cause arrhythmia and even death.) Metz also ran bloodwork, which revealed high cholesterol and estrogen that had dropped to menopausal levels, both of which are common side effects of anorexia. Metz showed her patient the test results and said, "None of this is okay." It was a profoundly sobering moment for Towne. "My other doctors had never even noticed," she says. "It was the first time I understood that my health was in more danger now that I was underweight than when I'd been at my highest weight."

QUESTIONING THE WEIGHT-CENTRIC MODEL OF HEALTH CARE

TO METZ, Towne's lifelong health-care experience is a classic example of how negative beliefs about high body weights lead to bias-informed medicine that hurts rather than

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heals. In Towne's case, her doctors' focus on weight loss to manage her diabetes led them to miss other red flags and even to reinforce her disordered eating behaviors. In May 2018 a Canadian woman named Ellen Maud Bennett died only a few days after receiving a diagnosis of terminal cancer; in her obituary, her family wrote that Bennett had sought medical care for her symptoms for years but only ever received weight-loss advice. "We see this kind of stigma all the time in the typical medical visit when patients are shamed about their weight," Metz says. "Assumptions are made about their health and lifestyle based on their size, and they often receive recommendations for weight loss rather than evidence-based treatments for their health conditions."

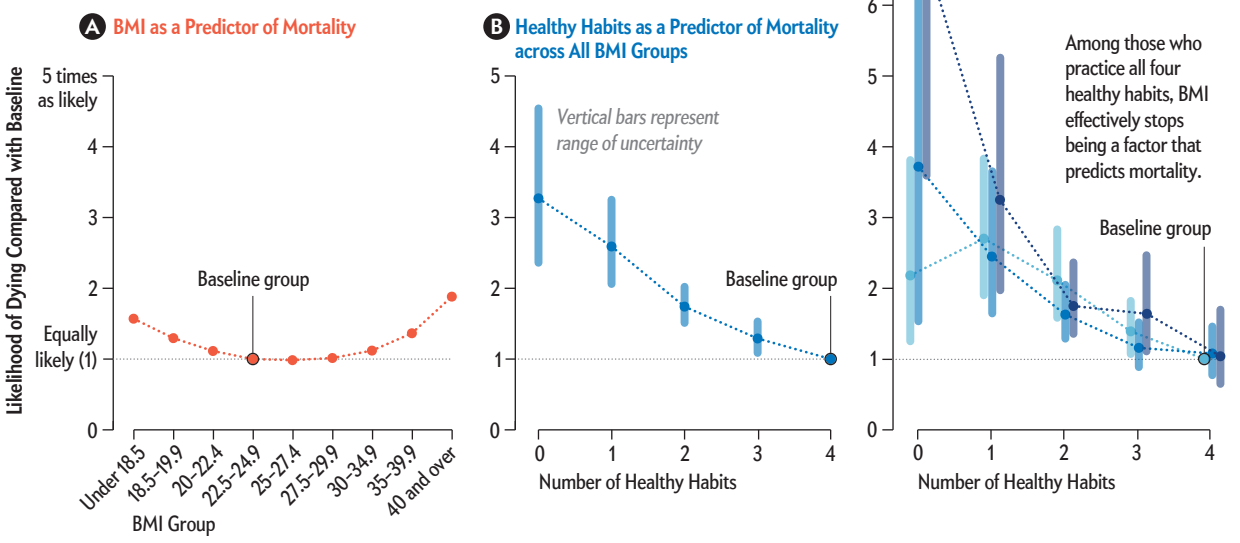
Metz, who attended the Duke University School of Medicine and did her residency in San Francisco before becoming an attending physician in New York, estimates that her first five to seven years as a doctor were spent in that same weight-centric mode. "My private-practice patients all came in asking about weight loss, and I jumped right into it," she says. Indeed, it is what the vast majority of health-care providers have long assumed they should focus on since the early 20th century, when the life insurance industry began to collect data showing that a higher body weight predicted a shorter life span. In the 1970s physiologist Ancel Keys published research establishing a correlation between dietary fat and heart disease and proposed the modern BMI system, a measure of body fat based on weight and height that is used by many doctors to categorize health by weight.

By 1985 the National Institutes of Health had adopted the BMI as one of two official ways to assess body fat, and in 1998 an expert panel convened by the NIH put in place guidelines that moved 29 million Americans who had previously been classified as normal weight or just overweight into the overweight and obese categories. "This created the 'obesity epidemic' and really intensified the focus on weight as a risk factor for health," says Jeffrey Hunger, an assistant professor of social psychology at Miami University in Oxford, Ohio, who studies health in stigmatized populations.

Defenders of the 1998 guidance say that research strongly supported the need for that shift and for medicine's increased and laserlike focus on weight as a health risk. "It is virtually incontrovertible that obesity has some negative impact," says David Allison, dean and distinguished professor at the Indiana University–Bloomington School of

BMI vs. Healthy Habits

To improve health, doctors often advise their patients to lose weight. Research has shown, however, that it is the behaviors people practice—not the size of their bodies—that have the biggest impact on mortality. Research has found that whereas mortality risk increases for those with the highest and lowest BMIs, there is no increased risk for people in the middle range (overweight and low obesity) compared with that for those with BMIs in the normal range A. In another study, when researchers tracked the BMI and four lifestyle habits of 11,761 adults over 14 years, they found that regardless of their weight class, people lived longer when they did not smoke, drank alcohol in moderation, ate five or more servings of fruits and vegetables daily, and exercised 12 or more times per month. "If you're obese and you have a healthy lifestyle, you are no more likely to die early than a person of normal weight," says Eric M. Matheson, the lead author of this 2012 analysis B C. The "baseline group" is the reference against which all other groups were measured.


A BMI as a Predictor of Mortality
Likelihood of Dying Compared with Baseline
5 times as likely
Equally likely (1)
Baseline group
Under 18.5
18.5–19.9
20–22.4
22.5–24.9
25–27.4
27.5–29.9
30–34.9
35–39.9
40 and over
BMI Group
B Healthy Habits as a Predictor of Mortality across All BMI Groups
Vertical bars represent range of uncertainty
Baseline group
Number of Healthy Habits
C Healthy Habits as a Predictor of Mortality for Each BMI Group
BMI under 25
BMI 25–30
BMI over 30
Among those who practice all four healthy habits, BMI effectively stops being a factor that predicts mortality.
Baseline group
Number of Healthy Habits

Sources: "Association of BMI with Overall and Cause-Specific Mortality: A Population-Based Cohort Study of 3.6 Million Adults in the U.K.," by Krishnan Bhaskaran et al., in *Lancet Diabetes & Endocrinology*, Vol. 6; October 30, 2018 (*BMI data*); "Healthy Lifestyle Habits and Mortality in Overweight and Obese Individuals," by Eric M. Matheson et al., in *Journal of the American Board of Family Medicine*, Vol. 25, No. 1; January 2012 (*healthy habits data*)

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Public Health. "It's pretty clear that it leads to elevated blood pressure and chronic inflammation, which both lead to problems." But weight stigma (also known as weight bias), which is defined as the set of negative attitudes or beliefs that are expressed as stereotypes, prejudice and even overt discrimination toward people with higher-weight bodies, does harm, too. It can influence how scientists approach their research, leading to gaps in understanding of the relation between body size and health. It contributes to missed or delayed diagnoses and to chronic stress for patients. Meanwhile the medical community's goal of solving America's health problems by fixating on weight loss has proved nearly impossible to achieve.

Although the correlation between larger bodies and higher rates of heart disease, diabetes and other chronic conditions is well known, some of the mechanisms behind the relationship are not straightforward. Mainstream weight researchers argue that high body weight itself causes the elevated blood pressure and inflammation responsible for such conditions. Others, such as physiologist Lindo Bacon, say that the contribution of weight to health is complex and that the root cause of disease is more likely to be an intersection of the patient's genetics, life habits and environment.

In some cases, data have shown that a higher body weight can actually be protective against certain health conditions. In the early 2000s researchers began noticing that heart surgery patients with higher BMIs had better survival rates than their thinner counterparts; this phenomenon was dubbed the "obesity paradox" and has also been documented for patients with osteoporosis (in whom higher body weight is thought to improve bone mineral density), major injuries and some kinds of cancer.

The fact that a higher body weight actually helps people survive certain major illnesses could partially explain why individuals in overweight and low-obese BMI categories have an overall lower mortality risk, according to the large epidemiology analyses of body weight and mortality correlations in the National Health and Nutrition Examination Survey (NHANES), the first of which was published by the Centers for Disease Control and Prevention in 2005. This research documents a "J curve" for the relation between BMI levels and mortality, meaning that whereas mortality risk increases for those with the highest and lowest BMIs, there is no increased risk for people in the middle range—overweight and low obesity—compared with that for those with BMIs in the normal range.

"The nadir of that J-shaped curve is getting higher on the BMI scale as we track populations over time," explains Allison, who has studied the "obesity paradox." "It could be that we have better treatments, so obesity doesn't kill you as quickly as it used to." But the very fact that these findings are marveled over and classified as a paradox underscores the role of weight bias in how we think about weight and health, stigma researchers say. "A paradox is something contradictory or seemingly absurd," Hunger notes. "This term only exists because it's considered absurd that fat people could actually be healthy."

Scientific understanding of weight and health developed in tandem with cultural biases about body size, leading to a belief that weight is a matter of personal responsibility and willpower. Numerous studies dating back to about 1960 have documented how children, when shown pictures of kids with various body types, will nearly always rate the fat child as the one they like least. In a 1980 experiment, a public health researcher named William DeJong found that high school students shown a photograph of a higher-weight girl rated her as lazier and less self-disciplined than a normal-weight subject unless they were told her weight was caused by a thyroid condition. "Unless the obese can provide an 'excuse' for their weight … or can offer evidence of successful weight loss, their character will be impugned," he wrote.

DeJong's and others' early findings of weight stigma were regularly dismissed by mainstream researchers and health-care providers alike. Then, in the early 2000s, a wealthy donor named Leslie Rudd, who had made his fortune in the food and beverage industry, approached a group of weight researchers at the Yale School of Medicine and asked them to study the impact of this stigma on people in larger bodies. "I was once a lot more overweight than I am now, and it gave me a firsthand insight into what people who are overweight feel and the discrimination they face," Rudd was quoted as saying in a 2006 Yale press release. "There was very little work happening in this area," says Kelly Brownell, a professor of public policy at Duke and a former director of what became the Rudd Center for Food Policy and Obesity. Rebecca Puhl, then a graduate student of Brownell's, volunteered to lead the effort. "Basically, Rebecca created this field," Brownell says. "And we were pretty quickly dumbfounded by what we found."

Today ample evidence documents how people with larger bodies experience bias not only in health-care settings but also in their workplaces, their schools and the media. Puhl, who is now deputy director for the Rudd Center at the University of Connecticut, and other scientists are beginning to show how living with this kind of chronic internal and external weight stigma negatively affects physical and mental health. In March 2020 Puhl and 35 of her colleagues released a consensus statement in the journal *Nature Medicine* condemning weight stigma as "inconsistent with current scientific evidence demonstrating that body weight regulation is not entirely under volitional control and that biological, genetic and environmental factors critically contribute to obesity." They also issued a pledge, signed by more than 100 medical and scientific organizations, including the American Diabetes Association, to eradicate weight stigma by treating "individuals with overweight and obesity with dignity and respect," especially in the workplace and in education and health-care settings.

Yet weight loss continues to be promoted as a medical necessity for reducing mortality and managing chronic conditions such as heart disease and diabetes. That is why a small but growing group of weight researchers is pushing to replace the weight-centric model of health care with a "weight-inclusive" approach being pioneered by Metz and a few other medical practitioners around the country. Doctors who have embraced this strategy evaluate a patient's health and medical needs on the basis of blood pressure, cholesterol and other biomarkers, and they focus on the health benefits that can be reaped from improving behaviors related to diet and exercise regardless of whether such changes lower body weight. These factors may be more useful benchmarks for achieving healthy outcomes than BMI. A handful of randomized clinical trials and epidemiological studies have shown that improvements in diet and exercise habits can lower

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blood pressure and make other physiological gains even when study subjects do not lose weight, as Bacon and weight science researcher Lucy Aphramor concluded in their 2011 evidence review in *Nutrition Journal*. "What we're really doing is looking at patients as complex human beings rather than funneling all of our health concerns through their weight," Metz explains. "We're stepping back to look at how the different organs and bodily systems interact with each other and then how a patient's environment, and even society as a whole, impacts their health." If that approach could lead to healthier outcomes, would the medical and weight-science communities be ready to let go of the number on the scale?

HOW WEIGHT STIGMA HARMS

NEGATIVE ASSOCIATIONS with large body types appear to cause real harm in health-care settings. Kimberly Gudzune, an associate professor at the Johns Hopkins School of Medicine, has found that people who have been stigmatized for their weight in a doctor's office are less likely to come back. After analyzing audio recordings of 208 patient encounters with 39 primary care physicians, Gudzune found that doctors established less emotional rapport with their higher-weight patients, according to a study published in 2013 in the journal *Obesity*. In another paper, published in 2014, she found that 21 percent of patients with overweight and obese BMIs felt that their doctor "judged them about their weight"—and as a result, they were significantly less likely to trust their doctor.

This distrust appears to occur regardless of a patient's socioeconomic status. In one 2006 study, 68 percent of high-weight women reported that they had delayed seeking health care because of their weight, even though more than 90 percent of the study participants had health insurance. Gudzune says she observes this clinically all the time: "It's not unusual for me to see a patient who hasn't been to the doctor in 10 years, and now I'm telling them they have diabetes or hypertension. Who knows how many of those issues could have been prevented or at least better managed with earlier care?"

Even when patients with large bodies do continue to seek medical care, their provider's weight bias can compromise the quality of the care they receive. "Think about all the stereotypes we have that people with higher body weights are lazy, lack willpower and are uninterested in their own health," Hunger says. "If that's the lens you walk in with to a clinical encounter, of course it shapes the questions you ask and the attitudes you take toward your patients." Studies show that clinicians may be less willing to provide standard care to patients with high BMIs. In one survey of 1,316 physicians, 17 percent said they were reluctant to perform pelvic exams on patients with obese BMIs. In a 2011 study on patients reporting shortness of breath and several other ailments, medical students tended to prescribe weight-loss strategies rather than symptom management to patients with larger bodies.

Data have shown that a higher body weight can actually be protective against certain health conditions.

Metz says she first became aware of the prevalence of weight stigma in health care 15 years ago while working in a primary care practice at Duke. She knew that when she treated patients with eating disorders, it was critical to avoid weigh-ins or discussions of weight-loss strategies because any focus on body size could trigger their deeply internalized shame and their propensity toward disordered eating and other destructive behaviors. "But then I'd leave that patient and walk next door to see someone who didn't have a diagnosed eating disorder but really wanted me to help them lose weight," she recalls. Metz could not reconcile the disconnect she felt talking about portion control and calorie counting with larger patients—many of whom were dieting and exercising in extreme ways—when those same behaviors would be cause for concern in her thinner patients.

In fact, research suggests that restrictive eating disorders may be more prevalent in people with larger bodies. Classic anorexia nervosa is diagnosed in just 0.6 percent of Americans, perhaps in part because one of its diagnostic criteria is that patients must have reached an "extremely low body weight." But atypical anorexia, which was added in 2013 to the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders,* is now used to diagnose patients who would otherwise meet criteria for anorexia but are not underweight. A 2014 study found that 2.8 percent of women in the U.S. had this kind of anorexia by age 20. Other research on eating disorders suggests that patients who develop them at higher weights are as much at risk for medical complications such as dangerously low blood pressure and slow heart rates as thinner patients, and they often struggle longer before receiving treatment, probably because doctors ignore or misdiagnose their symptoms. "It wasn't promoting my patients' health to prescribe weight loss," Metz says. "It was doing harm."

The harm caused by weight stigma appears to go well beyond misdiagnosis. A 2016 analysis of data collected from more than 21,000 American adults in the National Epidemiologic Survey on Alcohol and Related Conditions found a significant association between a person's experience of weight stigma and an increased incidence of heart disease, stomach ulcers, diabetes and high cholesterol even after researchers controlled for their subjects' socioeconomic status, physical activity level and BMI.

Puhl and other weight-stigma researchers have conducted experimental studies that have shown that people randomly assigned to "weight-stigma stimuli" consistently have higher physiological stress responses, such as increased cortisol levels, than those assigned to nonstigmatizing experiences. (One study by psychologists at Rutgers University and the University of California, Los Angeles, involved a researcher telling unwitting volunteers that they could not participate in an exclusive shopping experience because they were too big and might stretch out the clothes.) These data suggest that weight stigma may be more than just unpleasant to live with; it might actually contribute to some portion of the poor health outcomes disproportionately seen in people with higher-weight bodies. "We know that physiological stress plays a role in body weight because higher levels of cortisol contribute to weight gain," Puhl explains. "Weight stigma is a form of chronic stress. So that has chronic health

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effects, both physiologically and in terms of how people cope with that stress."

If weight stigma can influence health directly by raising cortisol levels and blood pressure and indirectly by compromising the quality of care that patients with large bodies receive from their weight-biased doctors, is it possible that people with large bodies have worse health not just because of their literal size but also because of the way they are treated by the world for being that size? "Yes," Brownell says without hesitation. He does not dispute the evidence for biological pathways between weight and health. "Obesity causes changes in the body that in turn increase risk factors, which in turn lead to diseases," he explains. "But there are other pathways. And every pathway is exacerbated by the presence of weight stigma."

LETTING GO OF THE SCALE IS HARD FOR EVERYONE

AT THE MOSAIC CLINIC, Leslie Scott, a 50-year-old woman who is in for her physical, still wants to be weighed. It is what she is used to, she says with a shrug. The medical tech obliges, but Metz does not look at the number before the checkup. She is more concerned about her patient's mental health. During her last visit, Scott mentioned that it was difficult to juggle work and being the primary caregiver for her elderly mother. Today Scott says her brother recently died and that she has been feeling depressed.

Metz closes her laptop and scoots her stool closer to her patient. "I'm so sorry," she says. "That's a terrible loss." They talk for several minutes about Scott's symptoms, such as how she is struggling to sleep and to remember to eat meals. "I know I need to take better care of myself," Scott says. "I should probably start going back to the gym and walking more."

"Do you enjoy those activities?" Metz asks. "And is it doable with your busy schedule, even once or twice a week?" Scott thinks it might be. Metz moves on to review Scott's vitals; her blood pressure is slightly elevated. "This is not in a range where you need medication, but it's something we'll watch," she tells Scott.

"I think it's my diet and my weight," Scott says. "It used to be high a few years ago. Then I lost weight, but now I've gained it back."

Metz pauses. She chooses her next words carefully, making sure to avoid any hint of criticism of Scott or her previous doctors. "We hear a lot in health-care settings that weight loss itself treats conditions like blood pressure," she says. What the medical literature really shows, Metz continues, is it is not necessarily weight loss that helps; more likely, it is how our behavior changes. "So, I wonder: The time before, when your blood pressure got better, did you start to engage in different behaviors?"

"Well," Scott says, "I moved away from a stressful situation." Previously she worked 12-hour night shifts at the local jail; when she began a less dangerous day security job, "my blood pressure got worlds better."

Metz senses an opening. These are the moments when patients often begin to connect the dots themselves and see how fixating so entirely on their weight has gotten in the way of larger health goals. At another medical practice, Metz worries, Scott's body size might have made her depression all too easy to miss. When her blood pressure rose before, nobody asked Scott about her job or her eating habits, let alone her mental health as she struggled to balance night shifts with the pressure of raising three children alone. "It was always just, 'If you lose that weight, you won't have to take medication,'" Scott says.

Metz explains how the stress, lack of sleep and irregular eating habits caused by Scott's old job probably contributed to her previous hypertension. Then she notes how, in the months since her brother's death, Scott has begun struggling again with those same issues, albeit for different reasons. They talk through a plan to start managing Scott's depression with a combination of medication, counseling and some modest physical activity goals. Weight talk is off the table. "My concern for you right now is: Are you eating *enough?*" Metz says. Scott nods and laughs.

Even when doctors such as Metz want to offer an alternative to the weight-centric model of health care, they are often contending with patients who expect a weight-loss prescription. Yet weight is a trait that is far less mutable than experts have long thought. In the journal *American Psychologist,* an evidence review on the effectiveness of weight-loss interventions found that regardless of which diet people followed, they could lose some weight in the first nine to 12 months of any protocol, but over the next two to five years they gained back all but an average of 2.1 pounds. Nondieting control groups also gained weight during that time, though just 1.2 pounds on average. "The dieters had little benefit to show for their efforts, and the nondieters didn't seem harmed by their lack of effort," says Traci Mann, one of the paper's co-authors, who is now a professor of psychology at the University of Minnesota. "Weight regain appears to be the typical response to dieting, not the exception." Brownell, who studied public policy approaches to obesity prevention during his time at the Rudd Center, agrees that the data on efficacy and durability are "too discouraging," both because people struggle so much to lose weight and because their cycling between loss and subsequent regains seems to further elevate their risk for health issues.

Indeed, Dana Sturtevant, a registered dietitian, spent seven years managing weight-loss interventions in clinical trials comparing treatment protocols for hypertension. "Everybody on our trials did the same six-month curriculum, and they did lose some weight in those six months," she recalls. "But they were always back up to where they started, or higher, at our two-year follow-up. When I'd bring that up in meetings, the researchers would say, 'Well, it's the participants' fault for not adhering to our protocol.'" It never occurred to her colleagues to question that protocol or whether weight loss should be the goal in the first place. Sturtevant began to "feel

Doctors focus on health benefits that can be reaped from improving behaviors related to diet and exercise, regardless of whether such changes lower body weight.

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unethical" about her work; she co-founded an organization called the Center for Body Trust that teaches health-care providers how to offer trauma-informed and weight-inclusive care. "We have no evidence-based treatment for high body weight that leads to sustained outcomes," Sturtevant says. "If a medication had this kind of failure rate, doctors would stop prescribing it."

Metz laments the relatively small number of studies that compare weight-inclusive or "nondiet" treatments with weight-loss protocols. A 2005 study randomly assigned 78 women with obesity to either a diet protocol or a Health at Every Size intervention. For the latter, participants were counseled about body acceptance, encouraged to separate their self-worth from their weight, and educated about techniques for intuitive eating and strategies for finding physical activity they enjoyed. The dieters lost weight but regained it; they were more likely to quit the program and saw fewer overall improvements in health outcomes than those using the nondiet intervention. A 2018 study found that following a similar Health at Every Size protocol helped participants improve their psychological well-being, physical stamina and overall quality of life even though they did not lose weight. Such results are encouraging, but Metz says more data are needed to understand and fine-tune the approach.

One such piece of research, which Metz refers to often, is a 2012 analysis of the NHANES data published by Eric M. Matheson, a professor of family medicine at the Medical University of South Carolina, and his colleagues. They found that life habits were a strong predictor of mortality because regardless of their weight class, people lived longer when they practiced healthy habits such as not smoking, drinking alcohol in moderation, eating five or more servings of fruits and vegetables daily, and exercising 12 or more times a month. "If you're obese and you have a healthy lifestyle, you are no more likely to die early than a person of normal weight," Matheson says.

Some discrepancies exist in his data; for example, eating more vegetables was associated with lower mortality for folks in the normal and overweight categories but not for obese people, whereas exercising regularly appeared to help those in the normal and obese groups but not people in the overweight range. Matheson does not know how to explain those findings. But one possible explanation is that the weight classifications themselves are somewhat arbitrary, something that even the mainstream weight researchers acknowledge. "At every level of the BMI, people can have different degrees of body fat or be that size because of entirely different factors or combinations of factors," Allison says. "Their age, race, sex and genetic background all come into play when we try to say whether their level of adiposity will cause health effects. It's not as simple as saying obesity is bad. You have to know for what, for whom, for when."

Metz is not sure that she has figured out the best approach to health care, but she sees patients every day who affirm that she is evolving in the right direction. Midway through her physical, Towne mentions that she has recently been discharged from eating-disorder therapy. "That's wonderful!" Metz says, breaking into a warm smile. They talk a little more about Towne's diet as Metz thoughtfully frames the conversation, asking, "Does your body give you feedback after you eat that?" instead of offering prescriptive advice about what to eat or avoid, as a different doctor might have.

One risk of the weight-inclusive model is that conversations about "healthy habits" can still easily turn into more opportunities to judge patients for their ability to comply with doctor's orders; talking about portion control and "lifestyle changes" can come across as a coded way of encouraging weight loss. But Metz is determined to push only changes that are sustainable for her patients and that have clear benefits regardless of whether they lead to weight loss.

Towne tells me later that one of the biggest challenges of recovering from her eating disorder has been accepting that her weight is not something she needs to control. "I don't know if I'll stay in a smaller body. And that's complicated because I have a lot of leftover trauma around how I was treated as a bigger person," she says. But Metz helped her see that fixating on being small, rather than healthy, had led to serious medical ramifications. "Having a doctor who can so totally remove weight from my health care has been literally life-changing." ●

Virginia Sole-Smith is author of *The Eating Instinct: Food Culture, Body Image and Guilt in America* and a regular contributor to *Parents* and the *New York Times*. Follow her on X and Instagram @v_solesmith

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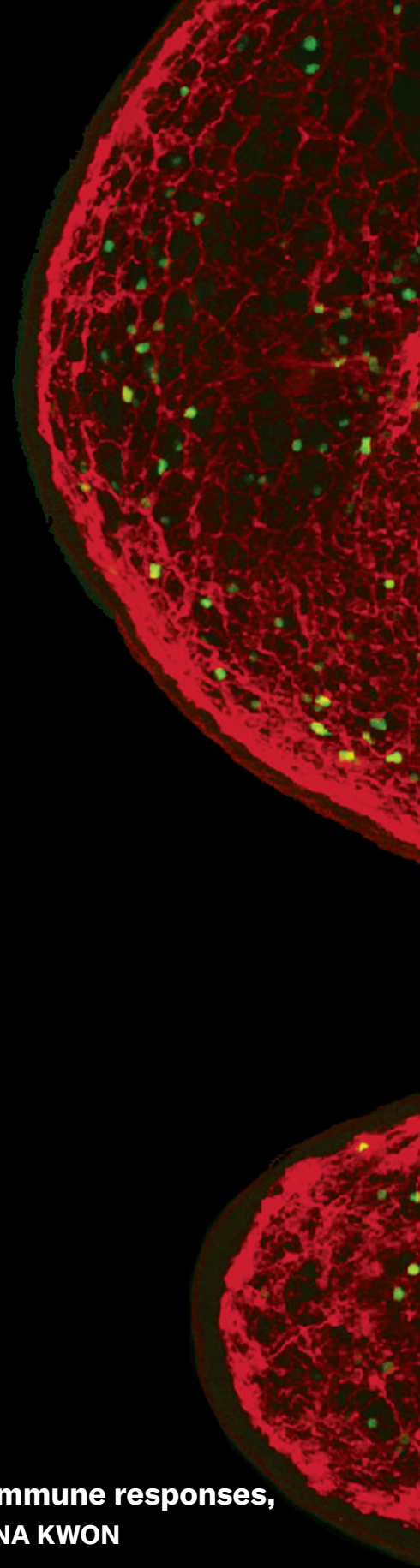

BRAIN OVER BODY

Scientists are deciphering how the brain choreographs immune responses, hoping to find treatments for a range of diseases BY DIANA KWON

Neuronal cells (*red*) in the gut interface with cells of the immune system (*green*).

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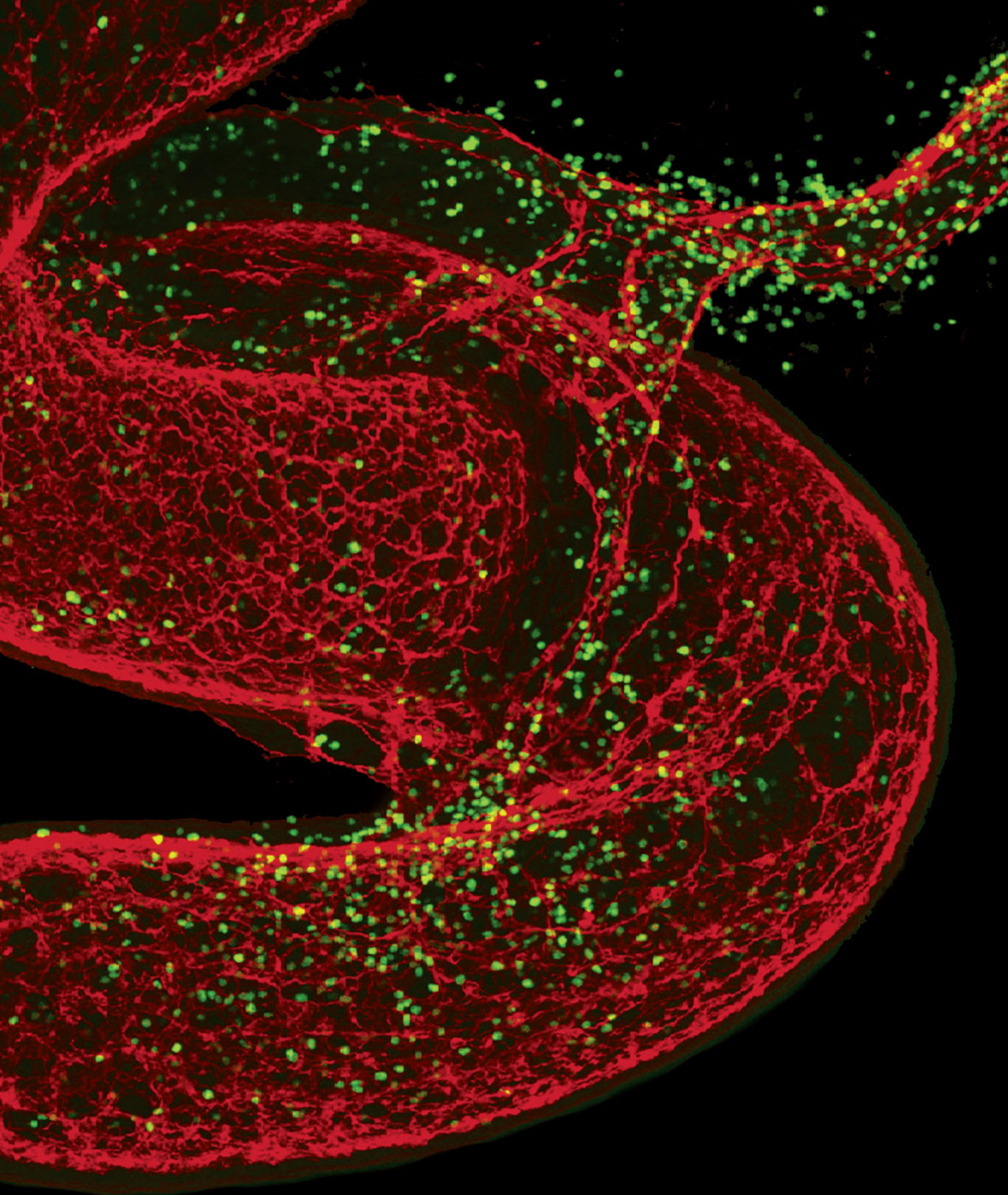

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HUNDREDS OF SCIENTISTS around the world are looking for ways to treat heart attacks. But few started where Hedva Haykin did: in the brain. Haykin, a doctoral student at the Technion–Israel Institute of Technology in Haifa, wants to know whether stimulating a region of the brain involved in positive emotion and motivation can influence how the heart heals.

In late 2022, in a small, windowless room, Haykin pulled out slides from a thin black box one by one. On them were slices of hearts, no bigger than pumpkin seeds, from mice that had experienced heart attacks. Under a microscope some of the samples were clearly marred by scars left in the aftermath of the infarction. Others showed mere speckles of damage among streaks of healthy, red-stained cells.

The difference in the hearts' appearance originated in the brain, Haykin explains. The healthier-looking samples came from mice that had received stimulation of a brain area involved in positive emotion and motivation. Those marked with scars were from unstimulated mice.

"In the beginning we were sure that it was too good to be true," Haykin says. It was only after repeating the experiment several times, she adds, that she was able to accept that the effect she was seeing was real.

Haykin, alongside her supervisors at the Technion—Asya Rolls, a neuroimmunologist, and Lior Gepstein, a cardiologist—is trying to work out exactly how this happens. On the basis of their experiments, the results of which have not yet been published, activation of this reward center in the brain—called the ventral tegmental area (VTA)—seems to trigger immune changes that contribute to the reduction of scar tissue.

This study has its roots in decades of research pointing to the contribution of a person's psychological state to their heart health. In a well-known condition known as broken heart syndrome, an extremely stressful event can generate the symptoms of a heart attack—and can, in rare cases, be fatal. Conversely, studies have suggested that a positive mindset can lead to better outcomes in those with cardiovascular disease. But the mechanisms behind these links remain elusive.

Rolls is used to being surprised by the results in her laboratory, where the main focus is on how the brain directs the immune response and how this connection influences health and disease. Although Rolls can barely contain her excitement as she discusses her group's eclectic mix of ongoing studies, she's also cautious. Because of the often unexpected nature of her team's discoveries, she never lets herself believe an experiment's results until they have been repeated multiple times—a policy Haykin and others in her group have adopted. "You need to convince yourself all the time with this stuff," Rolls says.

For Rolls, the implications of this work are broad. She wants to provide an explanation for a phenomenon that many clinicians and researchers are aware of: mental states can have a profound effect on how ill we get—and how well we recover. In Rolls's view, working out the mechanism for this influence could enable physicians to tap into the power of the mind over the body. Understanding the link could help scientists boost the placebo effect, destroy cancers, enhance responses to vaccination and even reevaluate illnesses that for centuries have been dismissed as psychologically driven, she says. "I think we're ready to say that psychosomatic [conditions] can be treated differently."

She is part of a growing group of scientists who are mapping out the brain's control over the body's immune responses. There are multiple lines of communication between the nervous and immune systems—from

It wasn't until the late 1990s that neuroscience researchers began drawing connections to the body's master conductor, the brain.

Lara Santos/Veiga-Fernandes Lab *(preceding pages)*

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Neuroscientist Talma Hendler readies a participant for a brain scan. The results will inform a study of whether learning to control brain activity can improve a person's immune response to a vaccine.

Sagol Brain Institute/Tel Aviv Sourasky Medical Center

small local circuits in organs such as the skin to longer-range routes beginning in the brain—with roles in a wide variety of diseases from autoimmunity to cancer. This field "has really exploded over the past several years," says Filip Swirski, an immunologist at the Icahn School of Medicine at Mount Sinai in New York City.

Some parts of the system—such as the vagus nerve, a huge highway of some 100,000 nerve fibers that connects the brain to the heart, lungs, gastrointestinal tract, and other major organs—have inspired treatments for several autoimmune diseases that progressed to testing in clinical trials. Other studies investigating ways to recruit the brain itself—which some think could provide powerful therapies—are still nascent. Rolls, for one, has begun examining whether the pathways her team has found in mice are also present in humans, and she has launched a start-up company to try to develop treatments based on the group's findings.

Although these developments are encouraging to researchers, much is still a mystery. "We often have a black box between the brain and the effect we see in the periphery," says Henrique Veiga-Fernandes, a neuroimmunologist at the Champalimaud Center for the Unknown in Lisbon. "If we want to use it in the therapeutic context, we actually need to understand the mechanism."

A TALE OF TWO SYSTEMS

FOR MORE THAN A CENTURY scientists have been finding hints of a close-knit relation between the nervous and immune systems. In the late 1800s and early 1900s, for example, scientists demonstrated that cutting nerves to the skin could curb some hallmarks of inflammation.

It wasn't until the late 1990s that researchers in this field began drawing connections to the body's master conductor, the brain. Neurosurgeon Kevin Tracey, then at North Shore University Hospital in Manhasset, N.Y., and his colleagues found something unexpected while investigating whether an experimental anti-inflammatory drug could help tame brain inflammation caused by stroke.

When delivered into the brains of rodents that had experienced strokes, the drug had the expected effect: it reduced neuroinflammation. As a control, the team injected the drug into the brains of animals that had inflammation throughout their bodies, thinking it would work exclusively in the brain. To their surprise, it also worked in the body. "This was a real head-scratcher," says Tracey, now president and chief executive of the Feinstein Institutes for Medical Research in Manhasset.

After months of trying to determine the path of the drug from brain to body, the researchers decided to cut the vagus nerve. With that nerve snipped, the anti-inflammatory effect of the brain-administered drug disappeared.

Inspired by this discovery, Tracey's group and others continued to explore other ways in which the vagus nerve—and the rest of the nervous system—directs immune responses. A driving force for these developments, Swirski says, has been the advent of scientific tools that enable scientists to begin to chart the interactions between the nervous and immune

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Neuroscientists Catherine Dulac (*right*) and Jessica Osterhout look at images of neurons in the hypothalamus that control symptoms of sickness, such as fever and loss of appetite.

Kris Snibbe/Harvard Staff Photographer

systems in an unprecedented way. Some researchers are focusing on particular body systems. For instance, a team led by Andreas Habenicht, a cardiologist at LMU Munich in Germany, reported in 2022 that the interaction between immune cells and nerves in the outermost layer of artery walls modulated the progression of atherosclerosis, an inflammatory disease in which vessels become clogged with cholesterol and other substances.

Meanwhile Veiga-Fernandes and his group have documented clusters of neuronal and immune cells in various tissues and discovered how they work together to sense damage and mobilize immune reactions. His team is now looking at how these little switchboards can be controlled by the brain.

The brain itself is also beginning to give up its secrets. Neuroscientist Catherine Dulac and her team at Harvard University have pinpointed neurons in an area called the hypothalamus that control symptoms that include fever, warmth-seeking, and loss of appetite in response to infection. "Most people probably assume that when you feel sick, it's because the bacteria or viruses are messing up your body," she says. But her group demonstrated that activating these neurons could generate symptoms of sickness even in the absence of a pathogen. An open question, Dulac adds, is whether these hypothalamic neurons can be activated by triggers other than pathogens, such as chronic inflammation.

Just above the hypothalamus sits the insula, a region that is involved in processing emotion and bodily sensations. In a 2021 study, Tamar Koren, then one of Rolls's doctoral students, found that neurons in the insula store memories of past bouts of gut inflammation—and that stimulating those brain cells reactivated the immune response.

Rolls, Koren and their colleagues suspect that such a reaction might prime the body to fight potential threats. But these reactions could also backfire and start up in the absence of the original trigger. This could be the case for certain conditions, such as irritable bowel syndrome, that can be exacerbated by negative psychological states.

MIND OVER MATTER

MANY SCIENTISTS hope to pin down how such mental states influence immune responses.

Rolls and Fahed Hakim, a pediatrician and director of Nazareth Hospital EMMS in Israel, were inspired to investigate this question after coming across a 1989 study reporting that among women with breast cancer, those who underwent supportive group therapy and self-hypnosis in addition to routine cancer care survived longer than those who received only the standard treatment. Several other studies have documented a similar link between survival and the mental states of people with cancer.

To test the link, Rolls, Hakim and their team zoomed in on the VTA—the same region they targeted in the heart attack study and in a previous experiment looking at bacterial infection. This time they focused on mice with lung and skin tumors. Activating neurons in the VTA noticeably shrank the cancers. It turned out that VTA activation subdued cells in the bone marrow that would usually repress immune activity, freeing the immune system to fight the cancer.

Clinicians have known about the effect of positive

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thinking on disease progression for a long time, Hakim says. But this evidence has been largely anecdotal or correlational, so being able to identify a pathway through which such an effect occurs—and manipulate it experimentally in animals—makes it much more real, he says.

Negative mental states can also influence the body's immune response. In a 2022 study, Swirski and his team identified specific brain circuits that mobilize immune cells in the bodies of mice during acute stress. The researchers found two pathways, one originating in the motor cortex that directed immune cells to the site of injury or infection and another beginning in the hypothalamus—a key responder in times of stress—that reduced the number of immune cells circulating in the blood. Swirski's group subsequently started investigating the role of stress-mediated circuits in chronic inflammatory diseases.

Neuroscientist Jeremy Borniger of Cold Spring Harbor Laboratory in New York and his colleagues have also found that activating neurons in the mouse hypothalamus can generate an immune response. They have examined how manipulation of these cells can alter tumor growth.

Some groups are hoping to replicate their findings in humans. Swirski's team, for instance, plans to use tools such as virtual reality to alter people's stress levels and see how that changes their immune response.

Koren and Rolls are working with Talma Hendler, a neuroscientist and psychiatrist at Tel Aviv University in Israel, to see whether boosting the reward system in people's brains before they receive a vaccine can improve their immune response. Rather than stimulating the brain directly, they are using a method called neurofeedback. In this approach, individuals learn to observe and control their own brain activity, which researchers measure using methods such as functional magnetic resonance imaging.

THE ROAD TO THE CLINIC

OVER THE YEARS Rolls has chatted with her good friend Tehila Ben-Moshe about her research. Ben-Moshe is chief executive of Biond Biologics, an Israel-based biopharmaceutical company that focuses on using immune cells to target cancer. During one such discussion in 2022, Ben-Moshe realized that Rolls's brain-stimulation experiments were acting on some of the same immune cells her company was trying to target, and she immediately saw the therapeutic potential. "When I saw Asya's data, I couldn't believe what I saw," Ben-Moshe says. "The question then became, How can I translate what she's doing with mice into patients?" The two are working on launching a company.

Ben-Moshe and Rolls hope to harness existing brain-stimulation technologies—for example, transcranial magnetic stimulation, which uses magnetic pulses to alter brain activity, or focused ultrasound, which uses sound waves—to modulate the immune systems of people with cancer, autoimmune diseases, or other conditions. As a first step, their team reached out to companies that have developed such technologies. Before starting their clinical trials, Ben-Moshe and Rolls wanted to examine blood samples from past trials that used these techniques so they could see whether there were signs of immune system alterations before and after treatment.

Potential therapies targeting the vagus nerve are nearer the clinic. A company co-founded by Tracey—SetPoint Medical in Valencia, Calif.—has tested pill-sized nerve stimulators implanted in the vagus nerve in the neck in people with autoimmune diseases such as Crohn's disease, multiple sclerosis and rheumatoid arthritis. The team running the rheumatoid arthritis trial showed in a small study in Europe that its device can reduce disease severity. The technique is currently undergoing a randomized, sham-controlled trial (in which the control group receives an implant but no active stimulation) in 250 patients in various centers across the U.S.

> "You can call something psychosomatic, but in the end, it's somatic. How long can we ignore what is there?" —Asya Rolls *Technion–Israel Institute of Technology*

Rolls's hope is that this work will ultimately help physicians to understand, and act on, the mind-body connections they see in their practices. The need is clear: when Rolls put out a call to speak to psychologists from the hospital where her lab is based, the meeting room was packed. People from departments ranging from dermatology to oncology were eager to share their stories. Many clinicians pass people with seemingly psychosomatic issues on to psychologists, saying there is nothing physically wrong, one attendee said. This can be distressing for the person seeking treatment. Even being able to simply tell people that there is a brain-immune connection that is responsible for their symptoms can make an enormous difference.

It's time that both researchers and clinicians take the link between psychology and physiology seriously, Rolls says. "You can call something psychosomatic, but in the end, it's somatic. How long can we ignore what is there?" ●

Diana Kwon is a freelance science journalist based in Berlin.

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AGE OF OPPORTUNITY

A refined understanding of the adolescent brain could lead to improvements in education and mental health

BY LYDIA DENWORTH

ILLUSTRATIONS BY ALISON SEIFFER

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HERE IS A PARABLE for our time: There once was an adult who wanted to encourage eighth graders to eat healthier food. The adult designed a lesson plan full of nutritional information—why fruit and vegetables are good for you, why junk food is bad for you, and so on. A similar approach had worked with younger children. But the eighth graders declared the intervention—and, if we're being honest, the adult—boring. They carried on eating junk food, some of them in greater quantities than they had before.

Versions of that story play out in real life all the time, although the age of the adolescents varies, and the goal could be anything from reducing bullying or depression to increasing engagement with math. With discouraging regularity, researchers find that what works with younger children is no longer effective with adolescents. Eighth grade seems to be the inflection point.

If we thought more carefully about what it is to be an eighth grader, however, down to the level of changes in the brain, our parable could have a happier ending. Thirteen-year-olds are concerned with status and respect—these kids do not want to feel patronized by adults. In a study published in 2019 in *Nature Human Behaviour,* instead of nutritional information, researchers showed more than 300 eighth graders in Texas investigative reports revealing that food company executives use unhealthy ingredients, target young adolescents in their marketing, and won't let their own children eat their products. The students were outraged and began to see healthy eating as a way of taking a stand against being manipulated. For the next three months the students made healthier snack purchases in the cafeteria. And in a follow-up study, the researchers found that the students, especially boys, with higher levels of testosterone (a marker of pubertal maturation in both boys and girls) were most likely to respond well to the intervention.

Over the past couple of decades neuroscience has dramatically changed our understanding of the structural and functional changes in the brain during adolescence, which runs from around the age of 10 all the way into the mid-20s. It is a time of rapid brain growth and neuronal fine-tuning when young people are especially sensitive to social cues and rewards. More recent research has focused on how the adolescent brain interacts with the social environment. It shows that social context and acceptance strongly influence behavior. Adolescence might even constitute a sensitive period for social and emotional learning, a window of time when the brain is uniquely primed by neurochemical changes to make use of social cues for learning.

A growing group of researchers and clinicians see these neuroscientific findings as a chance to do things differently. When a young brain is looking for experience, teachers, parents and other influential adults should seek to capitalize on the richness of learning and stave off negative experiences such as smoking or drug use. This was a central idea in the 2019 National Academies of Sciences, Engineering and Medicine report on the promise of adolescence, which called for investments in programs and interventions that use the brain's capacity to change during adolescence to promote beneficial shifts in young people's life trajectories.

A sensitive period for social and emotional processing also suggests that certain phases of adolescence may be more opportune than others for certain approaches. Early adolescence in particular—from roughly age nine to 11—could be an opportunity to launch kids on a positive path by buttressing their sense of self and motivation to learn. The nutrition experiment shows the benefits of fine-tuning interventions for middle adolescents, who have been through puberty. And no one wants to suggest that it's ever too late to help young people in trouble, especially given that the most serious behavioral and health problems of adolescence tend to occur at 16 and beyond.

To meaningfully compare the results of which interventions work best at age 10 or 14 or 18 requires extensive longitudinal studies, which have not yet been done. Even so, the advances in developmental science appear

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poised to lead to wiser, more effective approaches to supporting young people's education and physical and mental health. These methods emphasize adolescents' concern with status and respect, their evolving sense of self in relation to the wider world, and their need to contribute and find purpose. Similar ideas already underpin the growing interest in social and emotional learning among educators. Rather than focusing on the storminess of the teenage years, these ideas offer a sunnier view of adolescence as a window of opportunity.

RETHINKING ADOLESCENCE

FOR DECADES much of the research on adolescence focused on its dark side. Although those years are the physically healthiest period in life, when strength, speed, reaction time, reasoning abilities and immune function all improve or peak, adolescence also brings alarming increases in rates of accidents, suicide, homicide, depression, alcohol and substance use, violence, reckless behaviors, eating disorders, obesity and sexually transmitted disease compared with the rates for younger children.

But a different interpretation of adolescence emerged in the 2000s, stemming from two important new findings. Neuroscientists showed that puberty ushers in a period of exuberant neuronal growth followed by a pruning of neural connections that is second only to the similar process that occurs in the first three years of life. They also showed that the maturation of the adolescent brain is not linear. The limbic system, a collection of brain areas that are sensitive to emotion, reward, novelty, threat and peer expectations, undergoes a growth spurt while the brain areas responsible for reasoning, judgment and executive function continue their slow, steady march toward adulthood. The resulting imbalance in the developmental forces helps to explain adolescent impulsivity, risk taking, and sensitivity to social reward and learning. From an evolutionary sense, much of adolescents' behavior pushes them to leave the safety of family to explore the larger social world—a step on the way to becoming independent adults.

Another line of research, from the human connectome project, shows that adult brains vary in their patterns of neural connections throughout the brain, whereas children's connectomes are less distinctive. Those differentiated patterns of connection emerge in adolescence—between the ages of 10 and 16, just when social values and cognition are developing quickly. And the changes in the connectome data show up on average a year to a year and a half earlier in girls than in boys, just like puberty does, which suggests that the two things are intertwined.

The idea that adolescence might constitute a sensitive period for social and emotional processing was put forward in 2014 by neuroscientists Sarah-Jayne Blakemore and Kathryn Mills, now at the University of Cambridge and the University of Oregon, respectively. Previous research had assumed that social-cognitive abilities such as theory of mind were mature by the middle of childhood, but Blakemore and Mills laid out the many continuing changes across adolescence in social cognition and the network of brain regions governing social behavior.

Sensitive, or critical, periods are windows of time when the brain is primed to make specific neural connections that depend on the input received. They are timed to when important information is available and most useful for development. For sensory processing such as vision and hearing, such periods are well defined with an opening, peak and closing. A brain deprived of sight or sound early in development will never be able to see or hear normally. Likewise, a sensitive period for language acquisition explains why people who learn a foreign language after puberty typically have an accent. Sensitive periods for social learning have been harder to pin down.

During adolescence the brain may be uniquely primed by neurochemical changes to make use of social cues for learning.

Animal research has identified some versions of sensitive periods for social learning. Songbirds can delay the closing of the sensitive period for vocal learning if they need more time to learn their songs, which usually happens in adolescence. "It's a gorgeous example of a sensitive period for learning that has social function," says Linda Wilbrecht of the University of California, Berkeley, who has studied sensitive periods in songbirds, mice and humans.

Neuroscientist Gül Dölen and her colleagues at Johns Hopkins University identified an adolescent critical period in mice for something called social conditioned place preference (social CPP). The research followed up on an observation by the late Estonian neuroscientist Jaak Panksepp. He presented mice with two different kinds of bedding—on one, the mice were alone; on the other, they were with friends. When the mice subsequently had a choice of bedding, adolescents, in particular, showed a preference for the bedding that carried a memory of friends.

Dölen ran similar experiments with roughly 900 mice at 14 different ages and mapped out exactly when this preference for place occurs. Triggered by changes in oxytocin that lead to increased synaptic plasticity, it peaks 42 days after birth (roughly age 14 in humans), when the mice become sexually mature. "It's a really important stage of their lives when they're leaving the nest and trying to create their own groups," Dölen

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says. "[In] that window of time, when they're really sensitive to what other members of their group are doing, when they're learning from their group, when they're forming attachments to the group—that's when that peaks." It seems the brain becomes alert to and rewarded by information it had previously ignored. "There's information flowing by us all the time," Wilbrecht says. "Once puberty and hormones pass through the circuit, suddenly those cues have meaning. They don't have salience until you shift into the adolescent phase."

PRIMED FOR LEARNING

THESE WINDOWS of rapid change create both learning opportunities and vulnerabilities. What adolescents are learning is all-important. "The adolescent brain is primed for social and emotional learning, to explore, to interact, to take chances so they can learn, but it all depends on what we do to give them scaffolded opportunities in order to learn," says psychologist Andrew Fuligni of the University of California, Los Angeles. Harmful experiences may lead to negative spirals from which it's hard to recover. Research has shown that earlier experimentation with alcohol and drugs makes an adolescent more likely to become addicted.

"When your brain is going under rapid reorganization, that's probably not the best time to introduce external chemicals," says developmental psychologist Anthony Burrow of Cornell University. "Your body and brain are paying attention in a slightly different way. [Your brain is] going to organize itself around what you've done to it at that particular moment."

Protective factors in the adolescent's environment could support positive trajectories. What do protective factors look like? They include supportive relationships with family and caretakers and access to resources such as scaffolded opportunities to learn in positive ways. They also include some elements that have previously been underappreciated. Fuligni's research shows that adolescents have a need to contribute to society and that doing so makes them feel valued and can safeguard against anxiety and depression. "Part of what the brain is designed to do during the teenage years is to learn how to contribute to the social world," Fuligni says. This need is particularly significant in adolescence, he argues, because it's a time when the social world is expanding and young people are becoming capable of "making contributions of consequence." These contributions can occur within peer groups, in the family, or at a larger societal level. It's no accident that recent social protest movements for gun control and against structural racism have been led in large part by young people.

Research shows that adolescents have a need to contribute to society, and doing so can safeguard against anxiety and depression.

The specifics of what today's adolescents are learning—and what they are not—may bear on the alarming rises in depression, anxiety and suicidal ideation at that age compared with earlier ages (as well as with previous generations). Some of the information they encounter about mental health may be amplifying their problems, says psychologist Nicholas Allen of the University of Oregon. He points to the controversial Netflix series *13 Reasons Why,* which included a detailed depiction of a character's suicide and which research suggests was associated with an increase in adolescent suicides. "Whether it's a supportive and solution-oriented discussion or whether it's a ruminative, hopeless discussion will have a big effect," Allen says. "Too often adolescents who are tending toward depression, anxiety or suicidal ideation have a tendency to ruminate, and they find friends—both online and offline—who feed that tendency rather than help the teenagers move beyond it."

EFFECTIVE INTERVENTIONS

THERE IS STILL DEBATE about how best to use the new neuroscientific knowledge to help adolescents. "We've learned an enormous amount about the brain, but the application of that knowledge is not straightforward," Allen says.

A big question is when to intervene. One argument for zeroing in on early adolescence is to act preemptively. Because so many of the problems of adolescence occur in the mid- to late teenage years, many interventions target that time. "If you're a developmentalist, that is too late," says Ronald Dahl, a pediatrician and developmental scientist and founder of the Center for the Developing Adolescent at U.C. Berkeley. "Smaller, more subtle, positive interventions earlier are probably a much more promising way to improve population health." The logic of that idea first struck Dahl when he was still practicing as a pediatrician. At conferences, he started mentioning the importance of reaching kids early and found educators nodding their heads. They introduced Dahl to the idea of the fifth grade slump and the eighth grade cliff, a phenomenon in which children's disengagement with education starts slowly with a dip in grades and participation around fifth grade, when most students are 10, and accelerates so that those same students are failing three years later.

The neuroscience also suggests that acting early could make sense. "What we're increasingly learning is that there's another node of new plasticity around the time puberty starts," Dahl said at a conference in early 2020. "We talk about this as a high-stakes pivotal transition in terms of patterns that are beginning to be shaped." In a study in Tanzania, Dahl and his col-

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leagues succeeded both quantitatively and qualitatively in reducing ideas of gender inequality among 10- and 11-year-olds with a series of technology lessons at which girls were as likely to shine as boys.

Others are wary of focusing too much on any one phase. They emphasize that what neuroscience contributes to the discussion is a reminder of what to prioritize. "What is the thing at this stage of life that is most plastic, that is open for input? That tells you where the risk is, but it also tells you where the opportunity is," Allen says. "What the brain science says is that you should be looking in this area: social and emotional learning."

It is not surprising then that those interventions that look most promising take into account adolescents' desire for status and respect, as well as their need to contribute and find a sense of purpose. According to Fuligni, the most successful volunteer programs give adolescents a say in what to work on and a chance to reflect on the work, and the projects also feel meaningful. Meaning seems to matter in other efforts, too. In a study of early adolescents participating in a 4-H program, Burrow found that those who were asked to write about their sense of purpose before engaging in an educational activity were more likely to engage with the activity and find it important and interesting. "Purpose is a pretty powerful form of identity capital because it's not just an answer to the question of who you are, but it's an answer to the question of who you're going to be and the direction you're heading in," Burrow says. "It's got legs."

Psychologist David Yeager of the University of Texas at Austin has been exploring how best to frame messages to teenagers and studying whether their effectiveness interacts with pubertal maturation, a sign that the neurochemical changes are playing a role. "You should be able to show that if you communicated respectfully to teenagers in a way that felt authentic and supported their autonomy and independence, you should have bigger effects for adolescents, especially if they're more mature in terms of their puberty," he says.

His research bears that out. One series of experiments showed that the way you frame a request to take medicine predicted different rates of compliance and furthermore that those rates varied with testosterone levels. Some 18- and 19-year-olds came into the lab and were given instructions in a condescending way: *I'm the expert, I know what's good for you, take this.* Another group of young adults were given instructions in a more respectful manner: *Let me explain the reasons this medicine can be useful.*

For ethical reasons, the medicine in question was actually a spoonful of Vegemite, a notoriously strong-tasting condiment. Asked respectfully, people were twice as likely to take the Vegemite. Furthermore, participants with higher testosterone levels were significantly less likely to take the medicine in the disrespectful condition and more likely to comply in the respectful condition. When Yeager and his colleagues manipulated testosterone levels with a nasal inhaler, they found that doing so made individuals with naturally low testosterone levels behave just like those with naturally high testosterone levels.

While the medicine study was a nice test of how respectfulness might matter, Yeager says that the 2019 nutrition study informing eighth graders about unsavory food industry practices, which he helped to lead, is even more promising. "That's the first direct evidence that these pubertal hormones sensitize you to status and respect and therefore change the way you respond to health messages," he says. "And not just how you respond in the moment but the way you internalize them and continue to keep acting on them after the treatment is over."

In other words, now we know more about what causes adolescents to put up a wall and resist attempts to change their habits, beliefs and ways of coping. That same knowledge offers ways to break down that wall. "It's only recently that we know how to work with those sensitivities and not against them," Yeager says. "I'd like it to be a wake-up call for adults who work with kids." ●

Lydia Denworth is a Brooklyn, N.Y.–based science writer, a contributing editor for *Scientific American,* and author of *Friendship: The Evolution, Biology, and Extraordinary Power of Life's Fundamental Bond* (W. W. Norton, 2020).

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HOW TO RAISE KIDS WHO DON'T GROW UP TO BE JERKS (OR WORSE)

Science-based advice for parenting kids to be generous, kind antiracists BY CLARA MOSKOWITZ

Catherine Falls/Getty Images

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THERE IS NO SHORTAGE of parenting advice in books and on the Internet, much of it conflicting—for instance, "Do sleep train your baby" versus "Don't, under any circumstances, sleep train your baby." But the vast majority of this guidance is based on anecdotal experience and personal belief; very little of it relies on evidence, found *Scientific American* contributing science writer Melinda Wenner Moyer, a parent of two. She set out to discover what science has to say about one of the most profound questions a parent can ask: "How do I raise my children to help make the world a better place?"

In other words, "How can I make sure my kids don't turn into selfish boors?" In her book *How to Raise Kids Who Aren't Assholes: Science-based Strategies for Better Parenting—from Tots to Teens* (G. P. Putnam's Sons, 2021), Moyer probes the research on how to encourage kids to be generous, honest, helpful and kind. She reviews studies on how to instill egalitarian beliefs and make sure kids know how to stand up against racism and sexism. And she talks to scientists about perennial parental struggles such as sibling rivalry, teaching safe sex and moderating screen time. SCIENTIFIC AMERICAN spoke to Moyer about science-based strategies for raising good citizens.

An edited transcript of the interview follows.

I love that this book addresses so many questions and insecurities I have as a parent. Why did you decide to write it?

I want my kids to be compassionate, kind, generous antiracists and antisexists. And I thought, "I can learn about how to raise my kids in these ways and to instill values based on science rather than just relying on my instincts." I was surprised by just how much research there was on these questions and how little of it was being covered.

There is already so much pressure on parents these days. I don't want to tell other parents what to do. But if I could write a book that gives parents tools that could change the world for the better, that feels important. I want this book to make parents' lives easier, to give them answers to questions they might have had and to give them the science and tools they've been looking for. I don't want to add to their burdens or add to the judgment that parents are under right now.

Were there any cases where you found the science went against what you previously thought and surprised you?

One of the core questions I had was, "How do I raise my kids to be generous and kind?" A lot of what we hear is about the importance of teaching giving and generosity. But the research I kept coming across stemmed from how we talk about feelings. That's surprising—why would that have anything to do with how generous children would become? It became clear that helping our kids understand their feelings gives them the capacity to understand others' feelings, and that helps them make decisions to help their friends and be more generous toward them. This is part of something called theory of mind—how to understand others' feelings. Research suggests that the more parents talk about their feelings and other peoples', the more kids are likely to be generous and helpful.

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What does science tell us about raising kids to be antiracist?

Parents often think if we don't talk about race, our children won't see it, won't develop racism. That is, in fact, the opposite of what happens. Kids see race from a very early age and are very tuned in to social hierarchies. They are like little detectives trying to figure out how social categories work in the world and why. They see that most American presidents have been white and that a lot of the kids at school who have the biggest houses, their parents are white. They think the simplest explanation is that white people are just better or smarter. The research shows we need to correct these misconceptions as children are developing them. We need to talk about it quite a lot, which is really hard for white parents; it's hard for me. Some of these approaches I learned for the book are hard. They take practice and are not instinctual, but the research shows those difficult conversations help even if they're not perfect.

I have a four-year-old daughter, and I don't think she has any idea yet that anyone thinks girls aren't just as good as boys. Is it really helpful to introduce her to the idea of sexism?

I had the same question, and I posed this to the researchers. My daughter and I were reading *Good Night Stories for Rebel Girls,* and every story we read touched on the sexism these women experienced and overcame. I kept thinking it was hitting my daughter over the head with the idea that she'd have to fight sexism. But I found that no, actually, they are already perceiving it often on some level, even if they're not bringing it up. They're seeing the presidents are all men, all these powerful people are all men. They notice. When we do bring it up and talk about it, it helps them work through it. It is counterintuitive.

One of the interesting things you mention in your book is that parents often worry that their child will be bullied and rarely worry that their child will be a bully.

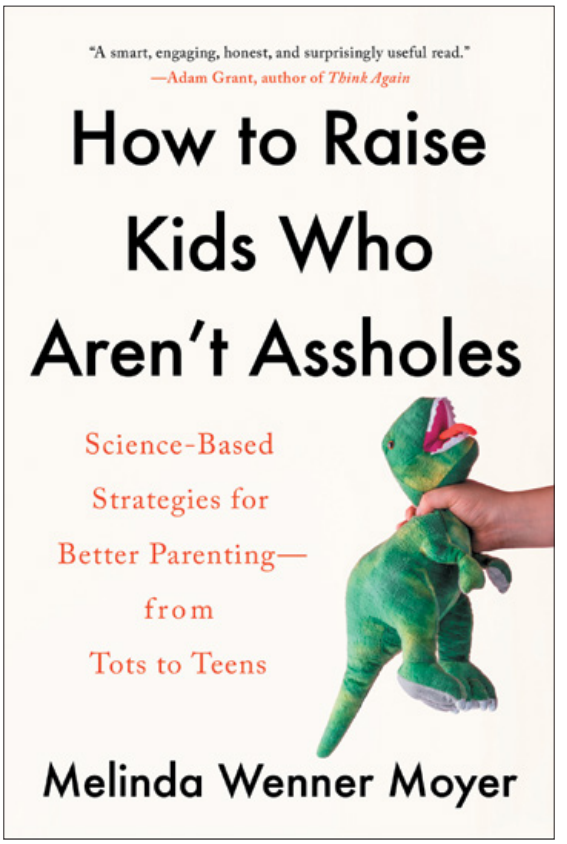
We have this idea that there is a type of kid that is a bully. But it's not just a bad seed who becomes a bully. Anybody can bully. We need to have regular conversations with our kids about this. Some of the research has found that kids who engage in bullying behaviors often don't realize their behavior is hurtful. It comes back to the idea of talking about feelings. Sometimes they aren't intentionally trying to hurt other people—they don't understand the impact of what they're doing.

Another fascinating chapter is about the dangers of pressuring kids for academic success.

That was a chapter that blew me away. I was surprised to find that our well-meaning desires for our kids to succeed and achieve can be so harmful to self-esteem. I was reading the research and thinking, "Am I doing this? Am I turning my child into a monster?" We all just want our kids to do better and better. We're worried about getting our kids into college, and our fears are grounded—it's harder than it used to be. But if we aren't careful, we can actually seed the very problems we're trying to avoid. If kids are constantly questioning themselves because they feel our love is contingent on how well they do and their grades, they're going to have so many issues with self-esteem.

Science is still trying to figure out how much nature and nurture affect personality. Do parents have a lot of room to influence who their kids will turn out to be?

I think genetics certainly play a role, but it's clear that environment and parenting do, too. We might have kids who start in different places with their propensity to be generous or have these other traits, but we can still move them in the right direction through how we parent. I observe that my two children have very different personalities and different inclinations toward generosity and empathy. But as I've learned to parent through the techniques I talk about in the book, I've seen both of them change. ●


"A smart, engaging, honest, and surprisingly useful read."
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How to Raise Kids Who Aren't Assholes
Science-Based Strategies for Better Parenting—from Tots to Teens
Melinda Wenner Moyer

Putnam

Clara Moskowitz is a senior editor at *Scientific American,* where she covers space and physics.

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OPINION

LET TEENAGERS SLEEP

Despite years of evidence that starting school later promotes better health and improved grades, too few schools have adopted this measure

BY THE EDITORS

TEENAGERS ARE SOME of the most sleep-deprived people in the U.S. On average, teens do not get enough sleep, and more important, they do not get enough quality sleep, according to researchers. We could blame cell phones and other light-emitting technologies for keeping kids awake at night, but late nights are just part of the equation. In addition to technology, one fairly indisputable factor contributes to this collective sleepiness: school start times.

Over decades researchers have amassed evidence showing that pushing back the first bell of middle and high school would benefit the physical, mental and emotional health of older children, not to mention their academic performance. The Centers for Disease Control and Prevention, along with several medical societies, has endorsed later start times. Some school districts, as well as the state of California, have already shown respect for that evidence with new start times.

Yet far too many school districts are reluctant to make the change, whether for logistical, financial or cultural reasons. This is unfair to teens. A generation of students is playing catchup from COVID, and we need to prioritize their health and wellness by pushing back the start of the school day. Honoring their biological and social needs will create more resilient adults who can thrive in a world filled with current complexities and future ones we can't begin to predict.

Teenagers need about nine hours of sleep a night—but they get closer to seven. And around puberty, their circadian clocks shift by a couple of hours, meaning they get tired later at night than before and wake up later in the morning than they used to. This

Illustration by Thomas Fuchs

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shift reverses at adulthood. The biological nature of this daily rhythm means that sending a teenager to bed earlier won't necessarily mean they fall asleep earlier.

Experts tell us that teens are missing out on both restorative sleep and REM sleep, especially the cycles that normally happen just before a person wakes up. Restorative sleep helps to repair the body after a hard day, and it may improve immune function and other biological processes. REM sleep solidifies events and learning into memories. So when a 10th grader who naturally goes to bed around 11 P.M. has to wake up at 6 A.M. for school, that teen is losing not only hours of sleep but hours of quality sleep. And even if they sleep in on the weekends, they won't fully catch up.

These kids are telling us they need more sleep. In survey after survey, they say when school starts later, they are not as tired all day, they tend to get to school on time, and they are less likely to have to be nagged to get out of bed. They tell us that as their sleep time decreases, their use of tobacco and drugs increases, including drugs that could help them stay awake. They tell us that getting one less hour of sleep a day leaves them feeling hopeless and, sometimes, suicidal. Research has shown that suicide risk in children increases during the school year, and sleep deprivation could be a contributing factor.

Other studies show that getting one less hour of sleep a day is associated with weight gain. Researchers have told us that sleepy teens are more prone to car crashes and that even 30 minutes of extra sleep would help alleviate some mental health concerns. Even teachers have reported that with later start times, their students are more engaged in the morning, and teachers themselves are more rested.

Despite decades of research, thousands of publications and clear science, schools in only a few states and the District of Columbia have pushed their start times to 8:30 A.M. on average, which researchers say is a compromise—a better time would be closer to 9 A.M.

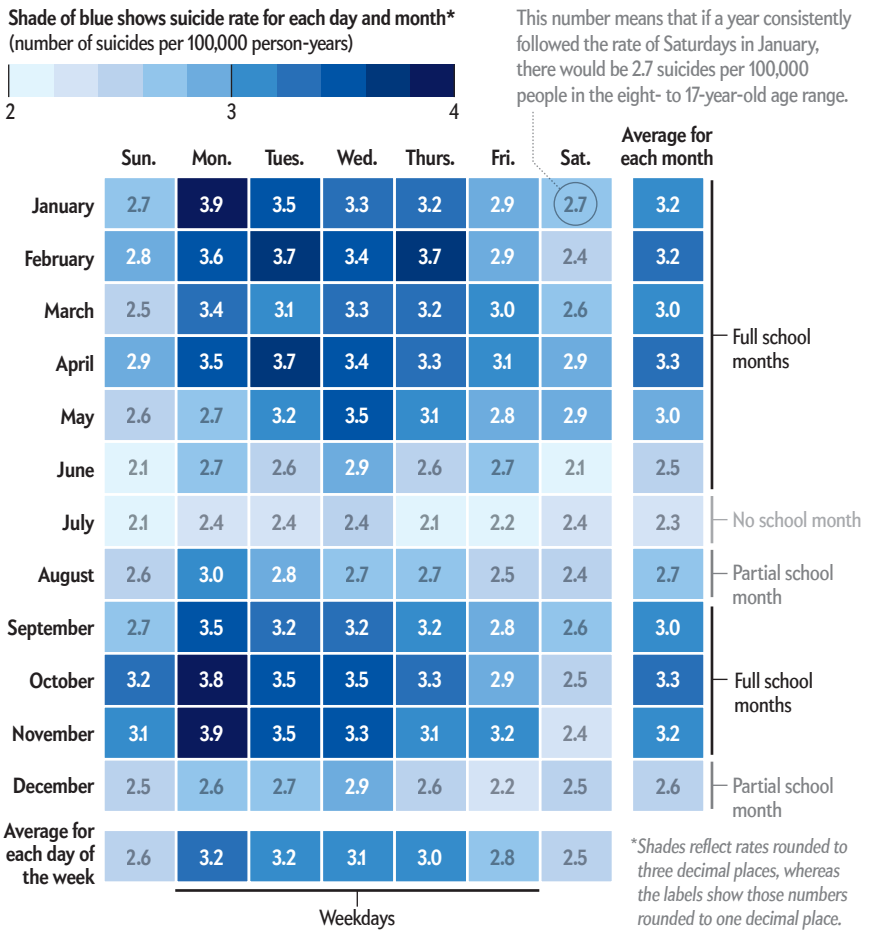
The path to delayed school start times is riddled with potholes. Bus schedules have to change. Teacher and administrator schedules have to be altered. After-school sports and enrichment programs might have to begin later. Parents and caretakers with more than one child may have to juggle childcare for older children to get the younger ones to their earlier start times. A delayed school start could also mean adults with inflexible work schedules are late for work.

Experts say our agrarian model of education was designed to get teens up early and home before dark to tend to the farm, but it is no longer relevant for most modern students. Our cultural views of teens as lazy and of needing sleep as a weakness are harmful and inaccurate. And our grumbling that if *we* survived early start times, today's teens can, too, is callous and dismissive of science.

Access to education is a basic right in the U.S. But it's time to stop thinking of school start times as immovable mountains. While more states ponder start time legislation, school district administrators should prioritize it, and people running for school boards need to add start times to their platforms. State-level funding agencies have to clear hurdles for districts wanting to try this. Employers need to be more flexible to help parents adjust to school schedules, especially with hourly employees. And the unions that represent teachers and other education professionals need to negotiate with teens also in mind.

For decades we've ignored the overwhelming evidence that delayed school starts help teens succeed. It's time to let teenagers sleep. ●

Suicide Rates Increase during the School Year


Shade of blue shows suicide rate for each day and month*
(number of suicides per 100,000 person-years)
2
3
4
This number means that if a year consistently followed the rate of Saturdays in January, there would be 2.7 suicides per 100,000 people in the eight- to 17-year-old age range.
Sun. Mon. Tues. Wed. Thurs. Fri. Sat.
Average for each month
January 2.7 3.9 3.5 3.3 3.2 2.9 2.7 3.2
February 2.8 3.6 3.7 3.4 3.7 2.9 2.4 3.2
March 2.5 3.4 3.1 3.3 3.2 3.0 2.6 3.0
April 2.9 3.5 3.7 3.4 3.3 3.1 2.9 3.3
May 2.6 2.7 3.2 3.5 3.1 2.8 2.9 3.0
June 2.1 2.7 2.6 2.9 2.6 2.7 2.1 2.5
July 2.1 2.4 2.4 2.4 2.1 2.2 2.4 2.3
August 2.6 3.0 2.8 2.7 2.7 2.5 2.4 2.7
September 2.7 3.5 3.2 3.2 3.2 2.8 2.6 3.0
October 3.2 3.8 3.5 3.5 3.3 2.9 2.5 3.3
November 3.1 3.9 3.5 3.3 3.1 3.2 2.4 3.2
December 2.5 2.6 2.7 2.9 2.6 2.2 2.5 2.6
Average for each day of the week 2.6 3.2 3.2 3.1 3.0 2.8 2.5
Weekdays
Full school months
No school month
Partial school month
Full school months
Partial school month
*Shades reflect rates rounded to three decimal places, whereas the labels show those numbers rounded to one decimal place.

Data published by the CDC and analyzed by emergency pediatric psychiatrist Tyler Black show a clear pattern: children die by suicide at much higher rates on school days than they do on weekends or during summer months. This graphic, originally entitled "Suicide Rates by Month and Day, Ages 8–17, 2000–2020," appeared in the online *Scientific American* article "Children's Risk of Suicide Increases on School Days," written by Black. Like many of his peers in pediatric medicine, he calls for later school start times, among other measures, to help improve kids' mental health.

Source: CDC Wonder, Centers for Disease Control and Prevention; Data analysis by Tyler Black

Graphic by Amanda Montañez

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BEING IN THE NOW

A focus on the present, dubbed "mindfulness," can make you happier and healthier. Training to deepen your immersion in the moment works by improving attention

BY AMISHI P. JHA

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PULLING INTO A parking spot at work, you realize you have no recollection of the drive that got you there. While reading a news story, you arrive at the bottom of the page, frustrated that you have no idea what you just read. In midconversation you suddenly become aware that you have missed what the person speaking to you has said.

These episodes are symptoms of a distracted mind. You were thinking about a project idea while driving, reliving a troubling memory while attempting to read, envisioning a weekend getaway with friends during a conversation with your co-worker. Whether the mind journeyed to the future or to the past, whether the thoughts that whisked you away were useful, unpleasant or pleasant, the consequences were the same. You missed the experience of the moment as it was unfolding. Your mind drifted into mental time travel.

AWAY FROM THE NOW

MENTAL TIME TRAVEL evolved to advantage our survival. By reexperiencing the past, we can learn from it, and by preexperiencing the future, we can prepare for it. Both *retro*spection (rewinding events in the mind) and *pro*spection (fast-forwarding them) rely on our brain's capacity for mental simulation. And based on the brain nodes and networks that carry out simulation, chief among them regions of the prefrontal cortex, we can glean that this is a recently gained evolutionary development. How does mental simulation work, and what does it have to do with stress and mind wandering (which is distinct from deliberate daydreaming)?

Before we discuss that, let's test our simulation abilities. Imagine being handed a delicious chocolate cupcake with creamy white frosting. You lift it up to your mouth, anticipating the rich chocolate flavor. But as you go to take a bite, I inform you that the frosting is made of cod-liver oil and cauliflower. The likely response: Yuck!

Let's break down what happened. The initial description of the cupcake prompted a mental image in your mind, and your attention transported you into a simulated experience, perhaps so vivid that you could almost taste the cupcake and feel your mouth watering. You recoiled as soon as you "pretasted" the seemingly disgusting cod-liver oil concoction.

Simulations have the power to transport our attention out of the present moment while simultaneously altering our cognitive, emotional and physiological responses in the now. The same mental powers that drove up your salivary response when you "previewed" a cupcake can drive down your mood, focus and thinking if you preview a threatening episode over and over. Worse, they can stimulate the pituitary gland to release more stress hormones. Herein lies the downside of this evolutionary advance: as our attention journeys to an alternative reality, our mind and body respond as if that reality were unfolding in the here and now.

Research suggests that this type of mental meandering away from our present moment has many deleterious consequences for our minds, bodies and relationships. Such mind wandering can spike during stressful times in our lives, be they acute or chronic events. And as mind wandering increases in the form of more frequent rumination or worrying, our experience of stress expands, creating a spiral of thinking that reduces our concentration while increasing our levels of stress hormones.

In my laboratory at the University of Miami, we study the human brain's attention system. To investigate whether and how stress influences attention, we partner with people in some of the most extreme, high-demand lines of work: medical professionals, firefighters, soldiers and elite athletes. They need to deploy their attention—and do it well—in extraordinarily high-stakes circumstances where their decisions could impact many people. One group we have worked with extensively is the U.S. military. Wheth-

We Are/Getty Images (*preceding page*)

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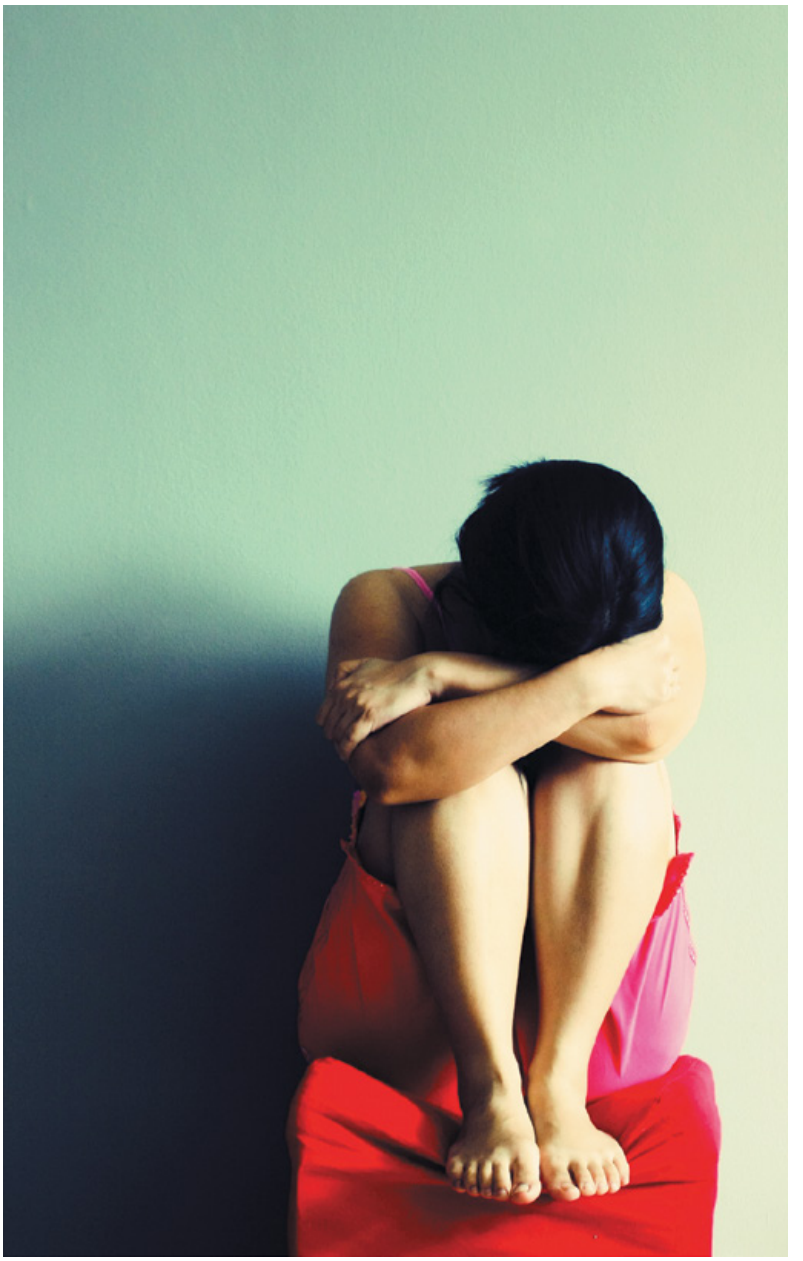
Modern mindfulness practices have their roots in customs that have been integral to Eastern cultures for millennia.



Learning to be more mindful, or aware of what is happening now, is an antidote to rumination, worry and fear—and their effects on mental health.

Apisit Sorin/Getty Images (*left*); Lesley Magno/Getty Images (*right*)

er and how people in this demographic pay attention can be a matter of life or death. For all of us, attention is a powerful force that shapes our lives far more than we realize.

Our attention influences our perceptual, emotional, decisional and social functioning and therefore affects our sense of fulfillment and accomplishment. Many of our participants experience protracted high-stress intervals, such as soldiers enduring predeployment training or military deployment, and we wondered what happens to attention over these intervals. We learned that, similar to what is observed in lab-based studies, experiencing stress in the field indeed causes attentional performance to decline while increasing mind wandering. This prompted the next important question: Can attention be trained to resist stress-related increases in mind wandering?

My group first considered mindfulness training as a potential solution in the early 2000s. If mentally zooming into the past or future was the root cause of "attentional hijacking," then perhaps the most effective antidote would be a training regimen that emphasized a present-centered attentional stance.

ANTIDOTE TO A WANDERING MIND

THE OPPOSITE OF A WANDERING MIND is a mindful one. Mindfulness is a mental mode characterized by attention to the present moment without evaluation or emotional reaction to it. Eastern cultures have proffered various forms of meditation as a solution to the conundrum of human suffering. Ancient texts detail precise training exercises to cultivate specific mental qualities. One form of meditation, which we now call mindfulness meditation, instructs practitioners to pay attention to ongoing perceptual experience rather than conceptual trains of thought. People have been engaging in mindfulness exercises for millennia,

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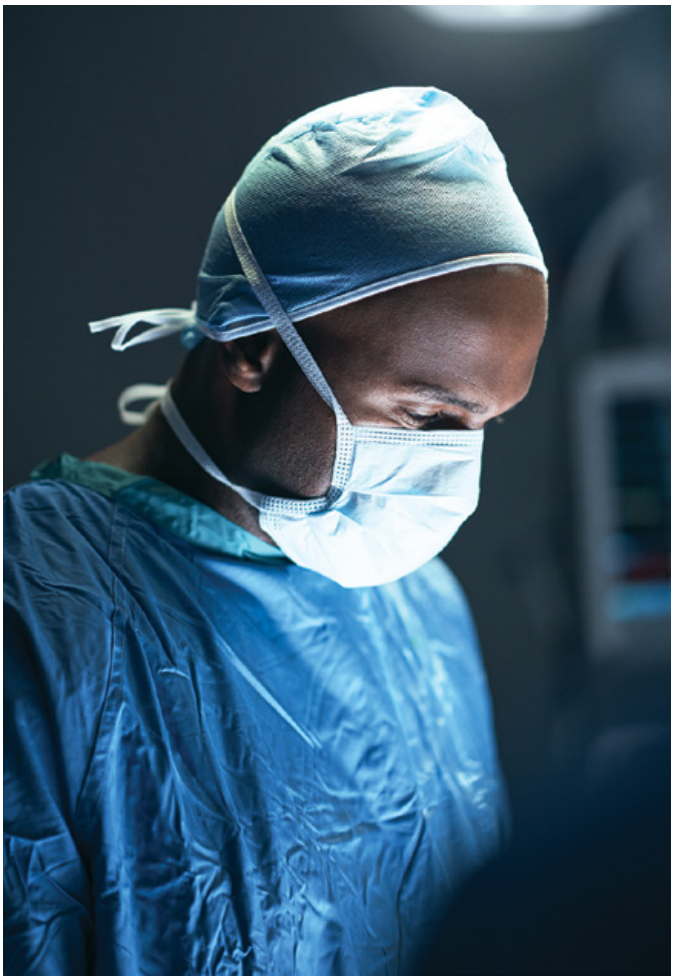

By improving the ability to direct and monitor attention, mindfulness meditation could enhance people's performance in pursuits as diverse as sports and surgery.

claiming improved mental clarity and calm—and even greater longevity.

Thousands of articles lay out evidence that training to become more mindful reduces psychological stress and improves both mental and physical health, alleviating depression, anxiety, loneliness and chronic pain [*see box on page 96 for a sample exercise*]. Many workplaces and medical centers now offer mindfulness-based programs to improve well-being. There has been an explosive proliferation of mindfulness training modalities beyond this as well, from apps and asynchronous online trainings to trainer-led in-person and remote programs.

One broad category of mindfulness exercises is focused-attention practices. These practices guide individuals to select a specific sensation tied to, for example, breathing and to direct attention to that sensation. Instructions next encourage practitioners to notice when their mind has wandered away from that attentional target and, when mind wandering is registered, to simply return attention back to the immediate breath-related sensations.

A second category emphasizes receptive-attention practices, which coach practitioners to engage in open monitoring. They are to watch what enters and then drops out of conscious awareness moment by moment. Think of hearing the faint sound of a fire truck's siren in the distance. The sound becomes louder as the truck approaches, then fainter again as it passes. You may notice that the siren is initially part of a vast sea of sounds and later the most salient sound, only to fade into the background again. Thoughts, emotions and other sensations may similarly grow and diminish as we remain in a watchful monitoring mode.

One of the best-studied mindfulness training programs was developed by Jon Kabat-Zinn of the University of Massachusetts Medical School in the late 1970s. The program, called mindfulness-based stress reduction (MBSR), introduces participants to both these broad categories of exercise. It is offered over eight weeks and involves weekly group meetings with a qualified trainer, as well as daily homework practices of 45 minutes a day.

As its name highlights, MBSR aims to promote stress reduction, as well as treatment for those suffering from any one of myriad ailments. The application and reach of MBSR have mushroomed over the past

Duane Osborn/Getty Images (*left*); shapecharge/Getty images (*right*)

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Courtesy of Amishi P. Jha Lab/University of Miami

Amishi P. Jha and Brigadier General (now Lieutenant General) Walter Piatt review brain-wave recording procedures, along with a memory test that military service members take before and after mindfulness training.

two decades, and it has guided many mindfulness-based interventions (MBIs) designed to improve the health of the body, the mind and relationships. These practices have been shown to alleviate stress-related inflammatory and cardiovascular diseases, as well as psychological disorders and diseases such as anxiety and depression. In addition, several studies report that MBIs improve interpersonal dynamics and team cohesion in the workplace.

TRAINING ATTENTION

FROM A CLINICAL PERSPECTIVE, although the field is admittedly in its infancy, the evidence is promising regarding the somatic, psychological and social benefits of mindfulness training. Yet my interest is from a cognitive neuroscience perspective: If mindfulness does work, *how* does it work? A review of mindfulness training exercises showed that they certainly highlight attention, but they also emphasize the detection of mind wandering. We needed to put mindfulness to the test in a manner that would allow us to assess both these components.

To do this, we used the "sustained attention to response" task, or SART. This test was developed in the late 1990s, and, as the name suggests, it tests a person's ability to sustain attention. Participants sit in front of a computer screen where a number appears for half a second and then vanishes. A half-second later, another number appears and then vanishes, and so on for 20 minutes. Their job: press the space bar every time a number appears—*unless* the number is three. By design, the number three appears only 5 percent of the time.

This test engages the three main subsystems of attention: orienting, or directing attention; alerting, or noticing events; and executive attention, or managing goals and performance. You orient attention to the screen, focusing on each number as it flickers; stay alert for the appearance of the number three; and use executive attention to make sure you are following the instructions and pressing the key only when you should.

It sounds simple, but it is not easy. Most participants do not perform well on this task. Why? They quickly go on autopilot, lost in their own mental simulations, and press the space bar no matter what number appears. Their attention goes off task. We know this because we stopped the experiment and asked

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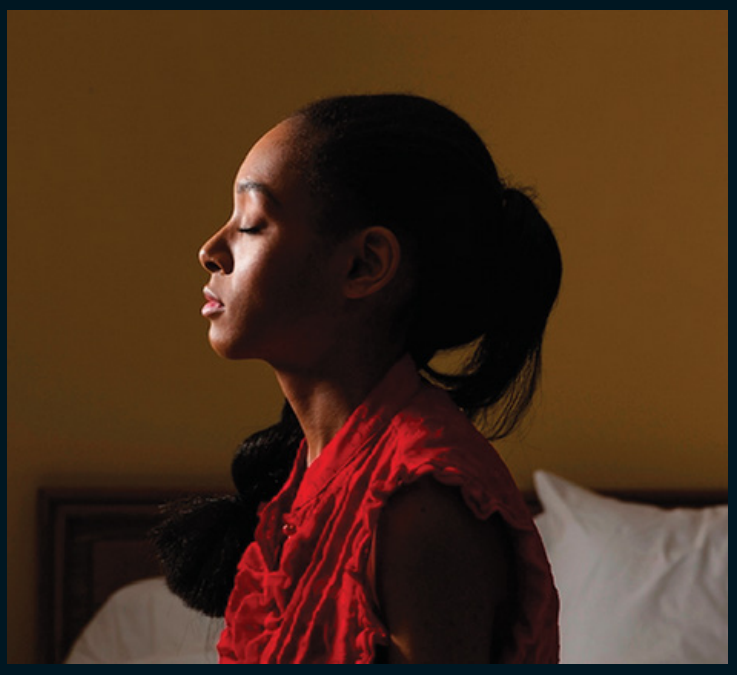
Capturing Attention

Mindfulness, a focus on the present moment without judgment, has proven benefits for health and happiness. Engaging in daily mindfulness workouts can help you assume this mental mode more often in your daily life. The following 10- to 15-minute mindfulness exercise is designed to train two types of attention: concentrative focus (a narrowing of attention and open monitoring) and a broad awareness of sensations and surroundings.

Here's what to do:

- Sit in an upright, stable position, hands resting on your thighs or cradled together.
- Lower or close your eyes, whichever is more comfortable for you.
- Attend to your breath, following its movement throughout your body.
- Notice the sensations around your belly as air flows into and out of your nose or mouth. You have been breathing all day—all of your life—and in this moment, you are simply noticing your breath.
- Select one area of your body affected by your breathing and focus your attention there. Control your focus, not the breathing itself.
- When you notice your mind wandering—and it will—bring your attention back to your breath.
- After five to 10 minutes, switch from focusing to monitoring. Think of your mind as a vast open sky and your thoughts, feelings and sensations as passing clouds.
- Feel your whole body move with your breath. Be receptive to your sensations, noticing what arises in the moment. Be attentive to the changing quality of experience—sounds, aromas, the caress of a breeze … thoughts.
- After about five more minutes, lift your gaze or open your eyes.

—*Scott Rogers,* director of programs and training, University of Miami Mindfulness Research and Practice Initiative



Zave Smith/Getty Images

them every now and then. Their minds wandered numerous times throughout the experiment, and during those episodes, their performance suffered compared with when they stayed on task.

We have used this experiment in many studies to see whether mindfulness training strengthens attention and reduces mind wandering in individuals experiencing intervals of high demand such as an academic semester or military deployment. We found that for a variety of groups ranging from undergraduate students to elite military units, mindfulness training indeed benefited SART performance. Compared with those who received no training, those in the mindfulness training groups had higher SART accuracy scores and less mind wandering over time.

In a 2020 study published in the *Journal of Cognitive Enhancement,* Frederikke Piil, then at the University of Southern Denmark, and her colleagues examined the consequences of acute stress and mindfulness training on SART performance in 48 university students and staff members. All participants were provided with one of two apps that required their engagement in daily practices over an interval of one month. One group used a mindfulness app to practice mindfulness exercises, and the other group used a cognitive training app to complete simple cognitive exercises.

To determine a baseline at the start of the experiment, participants first completed a cold pressor task—they submerged their nondominant hand in a tank of circulating ice water until it became too uncomfortable to keep it there. This task has been found to reliably increase stress as measured by increases in arousal of the sympathetic nervous system (for example, increased heart rate, blood pressure and stress hormones). Afterward they completed the SART. They returned a month later and once again completed the cold pressor task followed by the SART. Only the mindfulness group improved in their SART performance, and the more they used the mindfulness app, the more their performance benefited.

Because attention and mind wandering are known to correspond with academic performance, Clemens C. Bauer of the Massachusetts Institute of Technology and his colleagues used the SART test in combination with brain imaging in school-aged children. In their study, published in 2020 in *Human Brain Mapping,* half of 99 sixth graders received mindfulness training, and the other half received a computer-coding course.

After training, only the mindfulness group demonstrated preserved SART performance over the demanding academic semester. This group showed increased anticorrelation between activity in the central executive network, a key brain network for attention, and activity in the default mode network, known to be

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activated during mental simulations and mind wandering. Greater anticorrelation between these two networks after training indicates that only members of the mindfulness group improved in their cognitive control. These results suggest that mindfulness training may help children to stay focused and complete the task at hand.

Interestingly, work by Lukas Lenhart of the Medical University of Innsbruck in Austria and his colleagues in which participants received seven weeks of mindfulness training revealed altered brain structure in specific nodes tied to attention and mind wandering. In that study, published in 2020 in *Behavioural Brain Research,* 27 participants received an MRI scan before and after the mindfulness course. The researchers observed increased gray matter density in subjects' frontal lobe nodes within attentional networks, as well as decreases in gray matter density within nodes of the default mode.

Together these studies suggest that mindfulness training may provide a type of mental armor during times of protracted and acute stress and can serve to boost focus. It appears to benefit both children and adults, resulting in functional and structural brain changes. Such training allows us to break free from a wandering mind that can distract us from the task at hand and sour our mood. With our full capacity available to us, all aspects of our functioning that are fueled by attention will benefit, be it our ability to think, feel or connect.

PRESCRIPTION FOR THE BRAIN

EFFORTS TO BECOME MORE MINDFUL could make a considerable dent in human suffering. Working mindfulness practices into your daily routine may bring benefits similar to those of physical exercise. Indeed, as with physical exercise, mindfulness exercises are stress-protective, and the more you do, the more you benefit. As an antidote to an ambling mind, negative mood and stress, such mental workouts may have the potential to help virtually everyone live a happier, healthier and more fulfilled life. Students or athletes who want to boost their performance, for example, and parents, teachers or caregivers wishing to be more attentive to others' needs may all find mindfulness training useful. Such training may be particularly essential, however, for soldiers, first responders, critical care nurses and physicians, and air-traffic controllers, whose ability to control and monitor their attention may be a matter of life or death.

A key insight from our research is that merely learning about the damaging effects of stress or the benefits, history or mechanisms of mindfulness training did not lead to attentional improvements. Only engaging in regular mindfulness practice did. In studies across military service members and athletes, among others, we found a dose-response effect; the more practice people engaged in, the more they benefited. But conversely, we also found that when we assigned 30 minutes of daily practice, most time-pressured participants simply did not comply. Some did the 30 minutes; others did none. We pursued this "dosing question" across several studies to arrive at a daily practice prescription to which participants were willing to adhere: 12 to 15 minutes a day five days a week. When this group followed through, we saw beneficial effects on their attention. The research continues, and many more studies will be required.

Mindfulness training may provide a type of mental armor during times of protracted and acute stress and can serve to boost focus.

With evidence of its benefits mounting come new challenges for mindfulness training. How can access be scaled up *and* meet the needs of specific groups? Based on our past research, my colleague Scott Rogers and I created a short-form program called mindfulness-based attention training (MBAT). Once we found the core program to be effective, we developed train-the-trainer methods to address scalability challenges. MBAT's modular structure and exercises allow for flexibility so the program can be customized for a variety of groups, from soldiers to medical students, athletes, business professionals, first responders and teachers. The linchpin of the program's success is the competency of the trainers. We are finding that more so than prior expertise in mindfulness, successful trainers must have familiarity with the cultural norms, sensitivities and stressors that a particular community faces.

The scientific literature on mindfulness training is still in its infancy, and many scientists are calling for more rigorous research methods such as standardized programs and better placebo-controlled designs. Yet the promise of mindfulness continues to generate much interest. The overarching message seems to be that the more time spent engaging in such training, the more benefits in attention. No matter our profession, as we learn to grab hold of our attention and become more meta-aware of our moment-to-moment experience, we gain the power to intervene in support of our own happiness and health. ●

Amishi P. Jha, author of the book *Peak Mind* (HarperOne, October 2021), is a professor of psychology at the University of Miami, where she serves as director of contemplative neuroscience for the Mindfulness Research and Practice Initiative. Her research investigates the neural bases of attention, resilience and mindfulness.

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READY FOR ANYTHING

Scientists have compiled evidence-based tactics for building resilience. Among them: rethink adversity, forge close friendships and tackle novel challenges

BY STEVEN M. SOUTHWICK
AND DENNIS S. CHARNEY

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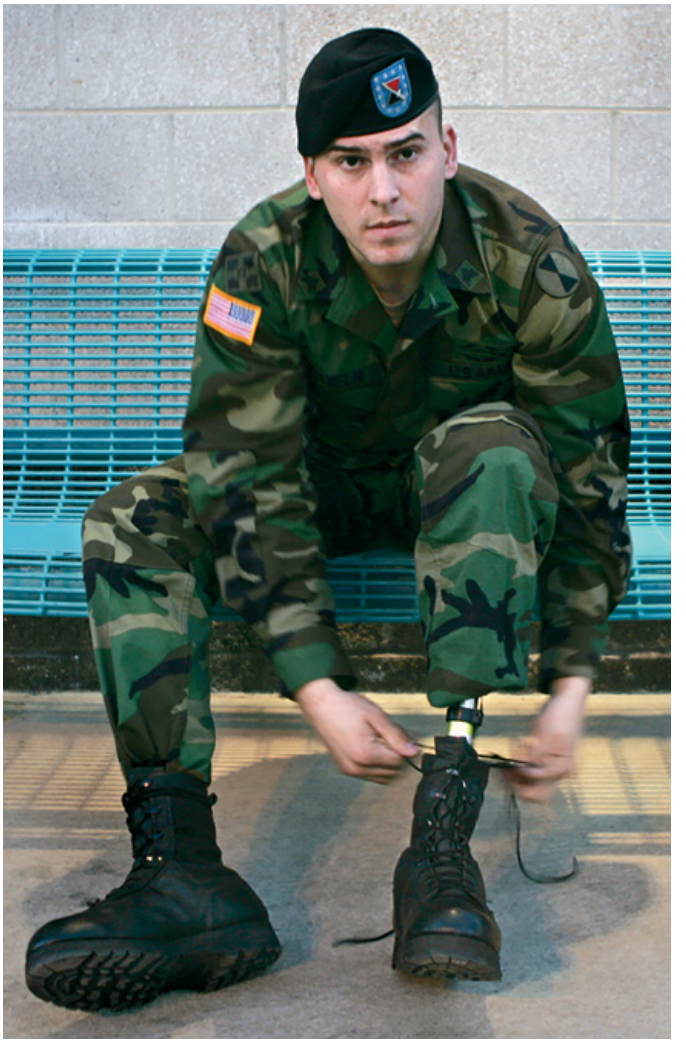
AS A COLLEGE STUDENT at Brown University, Jerry White spent his junior year abroad studying in Israel. On a sunny day during the Passover holiday in April 1984, White and two friends set out for a camping trip in the Golan Heights. "I was walking out ahead of my friends with a song in my heart. I like being the leader, the one out in front," he recalls. "Then, boom! A huge explosion." He had stepped on a land mine. As blood poured from his leg, White screamed, "I have no foot! I have no foot!" White's friends wrapped his stump with a shirt, tied a makeshift tourniquet around the injured leg and carried him through what they now knew was a minefield. For the next four months White lived in two Israeli hospitals where he felt helpless, sad and alone. "People were trying to introduce themselves, but they were all missing arms, legs, eyes, or they were burn victims. I felt sick and afraid," he says.

Eventually White returned home, completed college and worked as a substitute teacher before becoming an activist working on behalf of fellow victims. In 1995 he, along with his friend and colleague Ken Rutherford, who had lost both legs to a land mine in Somalia, founded the Landmine Survivors Network (renamed Survivor Corps). This group played a leading role in the International Campaign to Ban Landmines, which was awarded the Nobel Peace Prize in 1997.

White's transformation from frightened victim to passionate survivor demonstrates resilience, the "process of adapting well in the face of adversity, trauma, tragedy, threats or significant sources of stress," according to the American Psychological Association. Resilient people may bend but do not break when confronted with adversity, enabling them to bounce back relatively quickly.

Biologically, resilience is the ability to modulate and constructively harness the stress response—a capacity essential to both physical and mental health. Unchecked, chronic stress can impair the immune system and contribute to illnesses such as gastric ulcers, asthma, depression, diabetes and heart disease. Stress can also spawn unhealthy behaviors such as smoking and excessive alcohol use.



Wartime injuries need not be devastating. Many veterans learn and grow from their traumatic experiences.

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Resilience is critical to success. The ability to keep working toward a goal in the face of difficulty helps people in many types of professions thrive.

Success appears to hinge on resilience. This is especially important during times of prolonged stress and suffering, such as the COVID-19 pandemic. Setbacks are part of any human endeavor, and those who react to them productively will make the most progress.

Whether a person perseveres or gives up in hard times depends on influences at multiple levels, from molecules to neighborhoods. Resilience is determined by both inborn traits and environmental factors that affect the capacity to adapt to stress. Although some of these environmental influences, such as poverty, are difficult to alter, people can increase their level of resilience by developing mental and physical habits that foster positive adaptation to stress and trauma.

STANDING UP TO STRESS

BROWSE THROUGH the magazine section of any bookstore, and you will find an assortment of articles on how to reduce stress: "7 Rules for a Stress-Free Life," "Leave Your Stress Behind," "How You Can Reduce Your Stress and Your Dress Size," and so on. The basic message is that stress is bad—but it is not always. Some stress is actually good. Without stress, we would weaken. And difficulty that can be mastered facilitates growth, self-esteem, self-efficacy and resilience. A resilient person is thus not someone who avoids stress but someone who learns how to tame it.

A body of data, including studies of identical twins, suggests that certain personal characteristics that foster resilience may be at least partly inherited. These traits include a temperament that leads a child to confidently take on novel tasks and interact with unfamiliar people, as well as a good-natured, sociable personality. Researchers are now uncovering some of the basic biology of resilience that facilitates our adaptive responses to stress [*see box on page 105*].

Beyond biology, a number of environmental variables affect resilience, among them family support, the stability and quality of schools, and the services in and safety of a neighborhood. For example, a loner who is unemployed will have more trouble dealing with stress and trauma than a financially secure indvidual in a supportive family. Weak leadership in a community and insufficient first-responder and financial resources can also compromise responses to adversity.

Some of these situational factors, along with specific character traits, may be hard to change. Nevertheless, people can learn

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to think and act in ways that greatly enhance their resilience. Virtually anyone can become more resilient through disciplined, consistent practice. The more we activate specific brain areas through our behavior, the more neural connections form in those areas, which enables the neurons involved to transmit their messages more efficiently.

In our book *Resilience: The Science of Mastering Life's Greatest Challenges,* we identify 10 avenues for building resilience. Some of these strategies reduce stress. Others help you grow from the experience. Strategies to increase resilience include learning how to regulate your emotions, adopting a positive but realistic outlook, becoming physically fit, accepting challenges, maintaining a close and supportive social network, and observing and imitating resilient role models. We discuss each of these approaches below.

Engaging in mindfulness meditation is an effective way of controlling stress.

EMOTIONAL RESCUE

THE ABILITY to regulate emotions such as sadness, anger and fear is critical for effectively coping with stress and trauma. Negative emotions are natural and often adaptive, but if left unchecked, they can seriously compromise our ability to think clearly and to make rational decisions in challenging situations.

Researchers have devised various strategies for regulating emotions and enhancing resilience. Two approaches that have received scientific support are cognitive reappraisal and mindfulness meditation. Using reappraisal, individuals reinterpret the meaning of an adverse event so that they see it as less negative. Doing so tends to attenuate physiological and emotional reactions to the event. For example, psychologist Kevin Ochsner of Columbia University and his colleagues have shown that when people intentionally reinterpret a situation such as a rejection for a job as being less negative, they report a decrease in unpleasant emotions. Ochsner's team also found that this improvement in mood is accompanied by changes in the brain—in particular, an increase in activity in the prefrontal cortex, a center for planning, directing and inhibiting behavior, and a decrease in activity of the amygdala, a hub for feelings such as fear.

For years researchers have studied how people regulate their emotions. Individuals who frequently use cognitive reappraisal as a way to alter their emotional reactions to stress and trauma tend to report greater psychological well-being than those who do not look for neutral or positive ways to interpret their challenging circumstances. For example, in a 2008 study we, along with psychiatrist Adriana Feder and other colleagues at the Icahn School of Medicine at Mount Sinai, interviewed 30 former Vietnam prisoners of war about how they evaluated their wartime experiences. We found that most of these veterans, many of whom had been brutally tortured, had actively reappraised their imprisonment and found meaningful ways in which they had grown stronger, wiser and more resilient as a result of it. They also reported that they were now better able to see possibilities for the future, relate to others and appreciate life.

Training in cognitive reappraisal is a component of various therapies designed to enhance well-being, strengthen resilience and reduce distress. For example, cognitive-behavioral therapies, which are effective for treating mood and anxiety disorders, teach individuals to observe their own thoughts and behaviors, to challenge their negative assessments of stressful situations and of themselves, and to replace these with more realistic and positive points of view. When faced with a highly stressful or negative episode, you may find it helpful to ask yourself a few questions: "Is there a less destructive way to look at this situation?" "Am I catastrophizing or exaggerating its potential negative impact?" "Is there something that I can learn from

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Using a coping strategy called cognitive reappraisal, people can revise their interpretation of a difficult experience to make it less negative.

Martin Dimitrov/Getty Images

this experience, or is it possible to grow stronger as a result?"

Another strategy for controlling stressful emotions is to engage in mindfulness meditation. This exercise teaches practitioners how to consciously live in the present moment rather than dwelling in the past or fretting about the future. The participant becomes an observer who learns to watch, but not judge, as the mind tends to automatically follow familiar conditioned patterns of thinking that often add to distress and maladaptive coping. Mindfulness meditation has been associated with improved ability to focus; more flexible thinking; greater psychological well-being; and better ability to cope with depression, anxiety and stress.

Brain-scanning experiments have revealed that both mindfulness meditation and training in cognitive reappraisal can increase activation of the left prefrontal cortex (a pattern associated with greater emotional control), which provides a boost in positive emotions and faster recovery from feelings such as anger, disgust and fear. Attending a workshop on mindfulness meditation is one good way to start learning how to modulate the stress response and successfully weather life's many challenges.

A GLASS HALF FULL

IN ADDITION TO ATTENUATING negative emotions, a dedicated effort to bolster positive emotions can enhance a person's ability to bounce back from difficulty. Optimism and positive emotions are strongly associated with good mental and physical health, even longevity. In a remarkable study published in 2001, developmental psychologist Deborah D. Danner of the University of Kentucky and her colleagues examined autobiographical sketches composed by 180 nuns from the School Sisters of Notre Dame in Milwaukee before they took their vows of commitment to the Church and God. They found that the degree of positive emotion expressed in the sketches, which had been written decades earlier, predicted longevity. Only 34 percent of nuns whose sketches were classified in the lowest quarter of cheerfulness were still alive at age 85, compared with 90 percent who had been classified in the most upbeat quarter.

The health benefits of positive emotions probably stem from a better ability to regulate the stress response. Psychologist Barbara L. Fredrickson of the University of North Carolina at Chapel Hill and her colleagues have found that negative emotions

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tend to increase physiological arousal, narrow our focus of attention and restrict our behaviors to those essential for survival. Positive emotions, in contrast, have been found to reduce arousal and broaden our focus, leading to more creative and flexible responses to stress and trauma.

Resilience is associated with realistic optimism, not the rose-colored form. Because the latter often involves ignoring negative information, people who adopt an overly buoyant outlook tend to underestimate stressful and risky situations, whereas realistic optimists filter out unnecessary negative information but pay close attention to bad news that is relevant to dealing with adversity. To enhance optimism, focus on what is positive around you, intentionally think positive thoughts, embrace humor, reframe the negative in a more positive light, behave in ways that are known to be associated with positive emotions, and try to associate with positive friends and colleagues—emotions can be contagious.

Exercise can strengthen attention, decision-making and memory, empowering people to better shoulder stress.

Getty Images

WORKING OUT YOUR TROUBLES

PHYSICAL ACTIVITY can enhance resilience by protecting people (and animals) against the negative effects of stress. During the past two decades neuroscientist Benjamin N. Greenwood of the University of Colorado Denver and his colleagues have published a series of studies in rats showing that weeks of voluntary wheel-running exercise can ward off anxiety and depressionlike behaviors, such as exaggerated fear, reduced social exploration and increased intake of morphine, that can result from exposure to a variety of intense stressors.

In humans, aerobic exercise also has been shown to reduce symptoms of depression and anxiety. It improves attention, planning, decision-making and memory, all of which are important for effectively managing stress. Exercise appears to promote resilience through a number of neurobiological mechanisms. For example, it boosts levels of endorphins and of neurotransmitters such as dopamine and serotonin that may reduce symptoms of depression and elevate mood. It also suppresses the release of the stress hormone cortisol.

In addition, workouts seem to activate genes encoding proteins such as brain-derived neurotrophic factor (BDNF) that promote the growth and repair of neurons, which prolonged stress can damage. In a study published in 2011, psychologist Arthur F. Kramer, then at the University of Illinois at Urbana-Champaign, and his colleagues found that moderate-intensity aerobic exercise (three days a week for one year) increased the size of the hippocampus, a brain region that is involved in both memory and stress regulation, by 2 percent. This growth was associated with increases in BDNF levels and improved memory, suggesting that exercise can protect neurons in this area and may therefore help people recover from difficult circumstances.

For general health, the Department of Health and Human Services has recommended at least one hour and 15 minutes a week of intense aerobic workouts such as swimming or running or twice as much moderately intense exercise—mowing the lawn, say, or walking fast—along with two days of muscle strengthening. (Those who work out more tend to reap greater health benefits, although very intense or prolonged athletic en-

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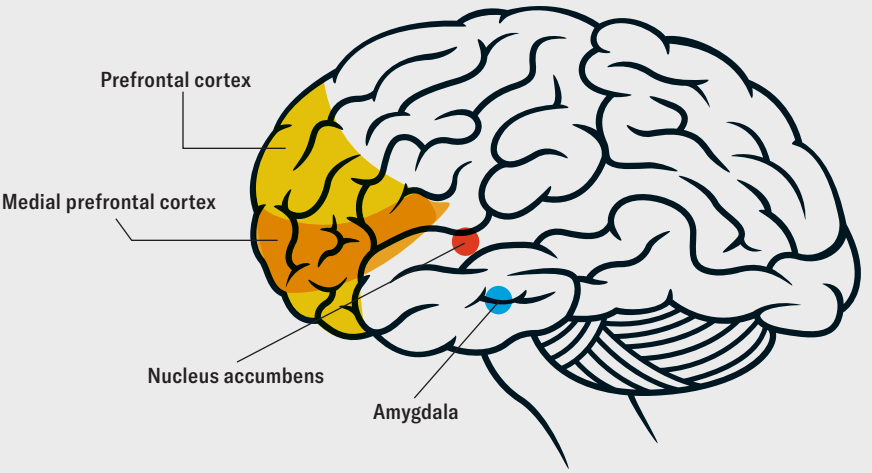
The Biology of Bouncing Back



Researchers have traced resilience, the capacity to recover from adversity, to a network of brain regions and chemicals. Beginning early in one's life, an individual's genes and the interaction of those genes with the environment shape brain circuits that underlie the psychological strengths and behaviors of resilient people.

Epigenetics helps to explain how the environment influences our genes. Our genes carry instructions for assembling every cell of our body. But the environment, including our behaviors, can change how genes are expressed. Stimuli such as fear, diet and social support can trigger biochemical reactions that turn genes on or off. Thus, genes are not destiny, and the degree to which they influence our lives might depend on our environment.

Critical to building resilience is the capacity to face fears, experience positive emotions, search for adaptive ways to reframe stressful events and benefit from relationships. Thus, resilience relies on neural circuits governing fear, reward, and social and emotional regulation. These circuits overlap at certain brain structures. For example, the amygdala not only regulates fear but also plays a major part in reward, through the processing of positive emotions. The nucleus accumbens, the hub of reward, also influences social behaviors such as sociability and pair bonding. The medial prefrontal cortex has a role in all three circuits, helping to regulate social interactions and emotions and relaying that information to other regions to inform higher-level decisions. As a result of the overlap and connections among these circuits, how a person faces fear is correlated with their ability to remain upbeat under stress and generate rewarding social experiences in tough times.

The neural circuits of fear, reward and social behaviors are powered by a variety of neurochemicals and hormones. One of these, neuropeptide Y, is a short protein found in the amygdala and other regions that mediate anxiety and fear. Among people under severe stress, such as someone undergoing challenging military training, higher neuropeptide Y levels are connected to better performance. High levels of the stress hormone cortisol, however, are associated with depression. Norepinephrine, another stress hormone, helps us react appropriately to danger by readying us to fight or flee the scene. Unrestrained repeated increases in norepinephrine may create chronic anxiety, however. Dopamine and serotonin, meanwhile, help us stay positive under difficult conditions.

Resilience may also be related to activation of the left prefrontal cortex. When active, this region at the surface of the brain just behind the forehead sends inhibitory signals to the amygdala, quieting anxiety and fear-based emotions, and leaving the frontal brain region free to plan and set goals. In this way, individuals are better able to persevere, maintain a positive self-image, remain hopeful in stressful times, and regulate their stress response so that it is deactivated when no longer needed. Understanding the biological underpinnings of resilience could help researchers and clinicians design psychological and pharmacological interventions that make people better able to overcome adversity.

—*S.M.S.* and *D.S.C.*

deavors can actually be detrimental to physical and mental health.)

To enhance resilience, however, we recommend that you consult with your physician and then develop a schedule in which you gradually increase the intensity of your cardiovascular and strength training. Every workout should be challenging but manageable. In this way, in addition to getting the biological benefits of exercise itself, you are also carefully calibrating your exposure to stress in a way that is known to increase resilience.

This general strategy is called stress inoculation. It is based on the notion that if someone deliberately takes on increasingly difficult challenges, they will gradually learn to handle higher levels of stress. The inoculation principle of graded exposure can apply to a broad range of activities designed to increase physical, emotional and cognitive resilience. For example, practitioners of mindfulness can increase their ability to concentrate by gradually lengthening their periods of meditation. A person who is afraid to give speeches might sign up for a public speaking workshop and afterward accept speaking engagements in front of small, nonthreatening audiences, then gradually agree to stand up in front of larger and more challenging crowds.

Such experiences should be outside your comfort zone but not so intense as to be unmanageable or potentially harmful. You should also plan to progressively increase the intensity or difficulty of these endeavors. As noted in the *U.S. Army Combat Stress Control Handbook,* "to achieve greater tolerance or acclimatization to a physical stressor, a progressively greater expo-

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Friendships can lift you up, provide security and prevent a precipitous fall.

CHBD/Getty Images

sure is required. The exposure should be sufficient to produce more than the routine stress reflexes.... In other words you must stress the system." Moreover, make training as realistic as possible. Pilots, firefighters, police and soldiers all enhance their physical, cognitive and emotional skills in realistic training settings where they can obtain constructive feedback from instructors and colleagues.

As you acclimate to greater levels of stress, you will need to recover and relax more. Psychologist James Loehr, who has written books on resilience training, points out that insufficient recovery relative to the high volume of stress can be quite damaging. One of the most important life skills may be knowing when high recovery needs to balance high stress.

FRIENDS IN NEED

A PARTICULARLY EFFECTIVE way to enhance resilience is to strengthen your relationships because doing so can dampen your biological response to stress and bolster your courage in tense situations. High levels of social support have been associated with better psychological outcomes after many types of trauma, including childhood sexual abuse and combat. High social support has also been linked with protection against depression and stress disorders such as PTSD, as well as greater emotional well-being and longer life. In contrast, social isolation has a negative impact on psychological and physical health, with effects on longevity similar to those of a sedentary lifestyle, obesity or cigarette smoking.

Backing from others is powerful because it increases an individual's self-confidence, provides a safety net if we should fall and bolsters our belief that we can overcome obstacles. As a result, we tend to more actively solve problems rather than passively avoiding challenges. After all, bonding with others does provide greater security; a group that works closely together is stronger than an individual. On a biological level, social ties activate the parasympathetic nervous system, which lowers subjective and physiological measures of stress and prompts the release of the hormone oxytocin. Oxytocin is known to reduce anxiety and fear, in part by limiting the cortisol response to stress. (It also promotes affiliative behaviors and emotions, such as trust, that encourage continued socializing.)

Interestingly, social support may have an even stronger effect on coping with adversity in Latin American and other cul-

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Taking on moderately stressful challenges, such as giving a lecture in front of a small group, can boost resilience.

tures that place great value on interdependence, extended kinship systems and collectivism. It plays a comparatively lesser role in more individualistic cultures, although relationships in all societies are vital.

To boost resilience through your relationships, first evaluate your social network. Make a list of the people you feel connected to. With whom do you interact daily? Who would help you without hesitation? To whom do you turn for advice? Who really understands you? Resilience is strongly associated with altruism and giving support to others.

If you find you need to bolster or simply maintain a supportive network, reach out to family, friends and colleagues. Join organizations that share your interests and concerns. Find ways to help others. As an adult, it is also important to teach kids the skills needed to become socially competent, such as knowing how to listen to and empathize with others.

MORE THAN FLATTERY

IN YOUR SOCIAL CIRCLES, look for people who recover quickly from hardship whom you could learn from. Members of your own family, colleagues, teachers, coaches, or even historical figures or fictional characters could also serve as resilient role models.

The late Albert Bandura, a highly influential psychologist at Stanford University, believed that modeling is most effective when the observer has analyzed what they wish to imitate by dissecting it into segments and creating rules that could guide future action. For example, when a friend lost her job, we noticed that she immediately called fellow employees, former employers and friends to solicit their help in searching for a new position. When she fell ill with pneumonia, she moved in with her sister until she recovered. And when her mother died, she called her family and closest friends and asked them to spend time with her. Rather than going it alone in times of stress, she reached out for support from those who care about her, a pattern that can guide our own behavior. Other resilience-enhancing attitudes and behaviors include perseverance and endurance, moral character and virtues, toughness tempered by compassion, altruism, dignity in the face of deprivation and potential growth from suffering.

The resilience-enhancing strategies we described earlier can be powerful tools for dealing with life's challenges. This includes collective challenges such as the COVID pandemic, which caused unprecedented levels of stress, trauma and depression among the general public and among frontline health-care workers, who risked their own lives to save the lives of their patients.

White, the land-mine survivor, is an outstanding model of resilience. Through years of soul-searching (read: cognitive reappraisal), he began to see the loss of his foot as more opportunity than horrendous misfortune. Together with a group of like-minded individuals, he embarked on a quest to rid the world of land mines. Through thoughtful reassessment, social support and a problem-solving approach, White transformed his tragedy into a mission of hope. ●

Steven M. Southwick was Glenn H. Greenberg Professor Emeritus of Psychiatry, PTSD and Resilience at the Yale University School of Medicine and the Yale Child Study Center. He died in 2022.

Dennis S. Charney is Anne and Joel Ehrenkranz Dean and a professor of psychiatry, neuroscience, and pharmacology and systems therapeutics at the Icahn School of Medicine at Mount Sinai. He and Southwick are authors of *Resilience: The Science of Mastering Life's Greatest Challenges* (Cambridge University Press, 2012).

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STOP DOOMSCROL

"Doomscroll Reminder Lady" Karen K. Ho explains how to step away from the screen

BY SOPHIE BUSHWICK

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READING THROUGH their social media feeds, Americans are likely to encounter anguished accounts of political turmoil, COVID surges and fallout from cyberattacks, among other less than cheerful topics. And yet many can't stop scrolling even more, perhaps hoping to distract themselves from thinking too hard about any one of these ongoing problems. The practice has earned a suitably apocalyptic nickname: doomscrolling.

In spring 2020, at the start of the coronavirus pandemic, Karen K. Ho, then a global finance and economics reporter at the news site Quartz, began tweeting regular reminders to step away from the screen and do something that will actually make a doomscroller feel better—such as getting a drink of water, stretching or simply going to bed on time. "Those first couple of months I was basically talking out loud to myself," she says. But her alerts drew attention from mainstream news outlets as well as fellow social media users, and in the year that followed, Ho's Twitter following doubled to more than 44,000 (Twitter was renamed X in July 2023). "It was helping people feel less alone about a practice that they knew to be harmful, and me trying to offer a solution in a way that isn't antagonistic or judgmental," she explains. "I think the thing that was really surprising to people was how consistent I was because nothing was really consistent. It was all really chaotic. And they felt like somebody was looking out for them."

SCIENTIFIC AMERICAN asked Ho in 2021 what her project has taught her about why people doomscroll—and how they can stop. "What doomscrolling does is rob future you of the energy you need to really focus on important things," she says, "and also to take better care of yourself."

An edited transcript of the interview follows.

Doomscrolling makes us feel bad—so why do we do it?

It's a combination of a couple of things. There is the very nature of the design of these applications. It's the slot machine effect: The old way was, you would find something really funny, educational or informative, and the surprise was not knowing when that moment of dopamine or delight would hit you. Then there's the compulsion for many people to be better informed about the chaotic situation that many of us are currently in as a result of the pandemic, the uncertainty regarding the economic recession, as well as the social justice situation affecting many minorities, women and vulnerable groups in the United States and around the world. Then I think, finally, it's a very limited act of agency that people still have. You and I can't go to our favorite restaurants, entertainment venues, gyms; we can't interact with friends and loved ones because of physical distancing measures. People can't do a lot of other normal behaviors, so they're able to exercise their agency in this limited way, even if it's detrimental to their ability to get a good night's sleep or reduce their stress.

Dean Mitchell/Getty Images (*preceding pages*)

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What can we do to prevent ourselves from endlessly scrolling?

I am a firm believer in using technology. New phones have ways for you to better focus: You can set manual time limits and hours in which you can't open the apps themselves. I've also used apps like the Chrome extension "Stay Focused" a couple of times, where you can set various time limits for checking [social media] on your computer. I also just manually log out on my work computer and my cell phone; I try to increase the friction required to log in and read the website. Then there's the emergency function: you literally just change the account password and give it to someone else so you can't log in.

I use a lot of operations management and scientific methods to get myself to not look at my phone. If you're going to pick up your phone more [at night], you have to put a book where your phone would normally be when you're not at work, to read that before you go to bed. One of the best tips is, I watch a lot of TV and movies with subtitles—like in foreign languages—because you can't look at your phone. You have to read what's on the screen to understand what's going on. When it's warmer, do things outside where you can't look at your phone. (When spring comes, I'm going to bike so much!) Also, I find other tactile hobbies, like puzzles or LEGO, to be really helpful. A lot of people have turned to writing cards and letters as an alternative activity during the pandemic. Some people like cooking; some people bake—it's really about personal psychology. Like, if you're fidgeting, it's just you feeling anxious about something. That's why you're checking Twitter, so that you're not thinking about the anxiety. Can you call a friend or a family member whom you haven't spoken to in a while instead of looking at your phone?

It's also about reminding myself constantly of things that sound really hokey and mindful. What I really remind myself of, repeatedly, is that when I die, Twitter means nothing. No one will be like, "I went viral a lot." They'll be like, "Did I have enough energy to do my job pretty well? Do the people we love know that we love them?" I think those are the things to really invest energy in.

Is there any way to snap yourself out of a scrolling session once you start?

Prevention is always better than trying to stop while you are in the middle of it. But if you're in the middle of it—that's why I send the reminders. I'm trying to meet people where they already are. There are several other Twitter accounts, like @tinycarebot, that are designed to catch you in the middle of doing it. And then there are alarms. I set alarms on my phone to be loud and obnoxious and say, "Hey, it's late. You should probably be going to bed." It's just setting yourself up, even before you start—ask "What are the processes to improve your rates of success?" Even if you go down the wrong path, how can you course-correct?

What are some other things to know about doomscrolling?

The thing to remember is that there are limits to individual responsibility and reminders to take care. Fundamentally it is an irrational response to a reasonable emotion—like about how frustrating it is to see the vaccine rollout be screwed up or the lack of mask mandates. There are lots of medical people who follow me because of the reminders, a lot of science reporters and health reporters, and they're doomscrolling because of repeated systemic failures by people in power. Doomscrolling existed for the Black community long before everybody else discovered it in 2020: when Black Americans are killed or hurt by police officers, there's a hashtag for their name.

A lot of doomscrolling is that feeling of lack of direction and helplessness. Doing something, having a series of steps for people to do, I find reduces their stress. So that's why you see me recommend drinking water or stretching—because unconsciously people let these things slide. When in doubt, I also find donating money makes you feel less helpless. It's not fair that people should only think about all of these huge, big-picture problems; this small thing you can do is go to sleep right now, instead of staying up late. ●

"You can set manual time limits and hours in which you can't open the apps themselves. I also just manually log out on my work computer and cell phone. Then there's the emergency function: you literally just change the account password and give it to someone else so you can't log in." —Karen K. Ho

Sophie Bushwick is an associate editor at *Scientific American*, covering technology.

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A Diet for Better Bones

Surprising findings on the roles of vitamin D, coffee and alcohol BY CLAUDIA WALLIS

AMONG MY FRIENDS, many of whom are women of a certain age, one topic seems to dominate our conversations about health: bones. It makes sense, given that 20 percent of American women age 50 and older have osteoporosis and that more than half have detectable bone loss (osteopenia). For men, the respective figures are lower: 4 percent and a third. Worldwide, one out of three women over age 50 and one out of five older men will develop an osteoporotic fracture—a hip, a wrist, a vertebra or two. Another reason for the endless jawboning about bones is mass confusion over how best to strengthen your skeleton and whether diet and supplements really make a difference.

Diet research is always messy, and study results on nutrition and bone health have been wildly inconsistent. But gradually some clarity is emerging. As we review our resolutions about what to eat year after year, it's useful to look at new data on vitamin D, as well as recent research on coffee and other foods.

Bone is a dynamic tissue, constantly replenished with new cells. Calcium is the key nutrient for building bone, and vitamin D enables the gut to absorb calcium from the food we eat, so doctors often recommend D supplements to counteract age-related bone loss. Today more than a third of American adults ages 60 and older pop this vitamin.

But to the surprise of many, a huge study published in 2022 in the *New England Journal of Medicine* found that taking vitamin D for five years did not reduce the rate of fractures in healthy adults age 50 and older. That result built on earlier findings, led by the same team, that D supplements do not improve bone density (or, for that matter, lower the risk of cancer or heart disease). An editorial accompanying the fracture study declared that it's time for medical professionals to stop pushing these pills and quit ordering so many blood tests for vitamin D levels.

"Food and incidental sun exposure likely provide enough vitamin D for healthy adults," says endocrinologist Meryl LeBoff of Brigham and Women's Hospital in Boston, who led the study. But LeBoff puts an emphasis on "healthy" adults. The study did not focus on those who already have osteoporosis and/or take medications for it. Such people would be wise to remain on extra vitamin D and calcium, she advises.

What does help to maintain strong bones for all of us? The easy answer is foods that are high in calcium, such as dairy products, sardines and tofu. Health authorities recommend a lot more calcium than most of us routinely get: 1,300 daily milligrams for kids ages nine through 18 who are building bone density for a lifetime, 1,000 daily mg from age 19 to 50, and 1,200 mg for women after 50 and men after 70. Federal surveys indicate that only 61 percent of Americans and just half of children hit these targets, which, admittedly, takes some effort. For example, you would need to eat at least three daily cups of plain yogurt or nearly nine cups of cottage cheese to get 1,200 mg of calcium. Getting it from food is best, LeBoff says, "because there are so many other nutrients, and you have a more continuous absorption than with a pill."

For those of us who like to start our day with coffee, modest consumption may help our bones. Although very high levels of caffeine—say, six to eight cups of coffee—cause calcium to be lost in urine, one or two cups seem to have a beneficial effect. A study led by Ching-Lung Cheung of Hong Kong University linked three digestive byproducts of coffee with greater bone density at the lumbar spine or upper thigh bone. "Coffee intake, if not excessive, should be safe for bone," he says, "and if you still have concerns, add milk!"

Alcohol, too, is best in moderation. Excessive drinking can disrupt the body's production of vitamin D and interfere with hormones that promote bone health. Fizzy water, in contrast, has been wrongly maligned: it does not weaken bones, although evidence suggests that cola and soda pop may do so.

The other key element of skeletal health involves calories out rather than calories in. Weight-bearing exercise stimulates bone formation throughout life. And you don't have to heft dumbbells. Just supporting your own weight while walking, running or jumping does the trick. So while boning up on better nutritional choices, add more exercise to your menu of daily resolutions. ●

Claudia Wallis, an award-winning journalist, was managing editor of *Scientific American Mind.*

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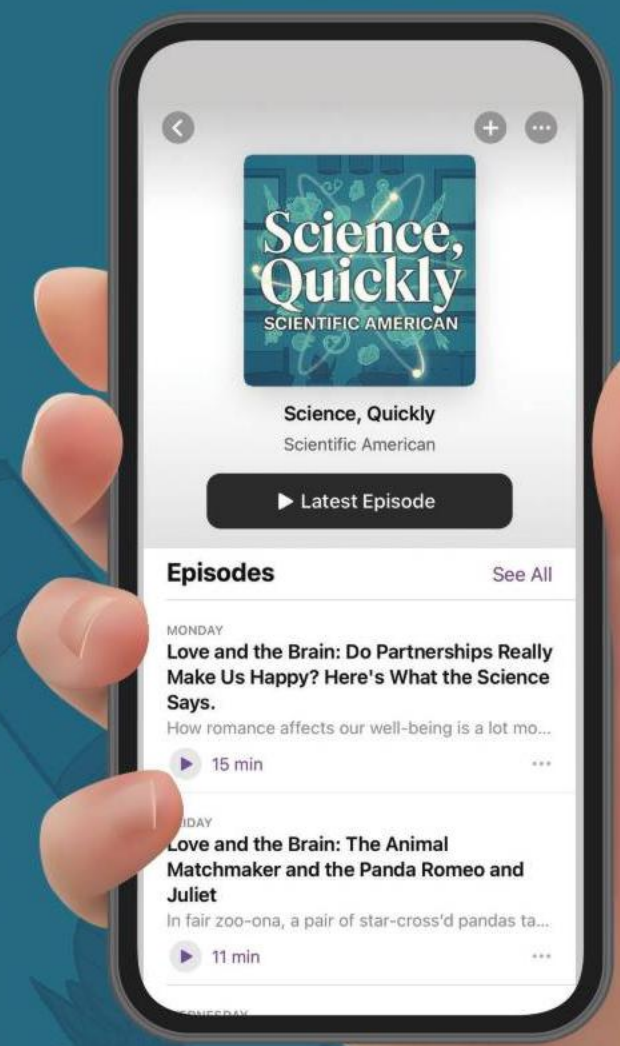
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